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## NOTES ON THE LIGNEOUS PLANTS DESCRIBED BY LÉVEILLÉ FROM EASTERN ASIA<sup>1</sup>

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### ROSACEAE

*Neillia sinensis* Oliv. f. *glanduligera* (Hemsl.), f. nova.

*Neillia sinensis* Oliv. var. *glanduligera* (Hemsley in herb.

*Neillia glandulocalyx* Léveillé, Fl. Kouy-Tchéou, 348 (1915).

A typo differt tubo calycis glandulis longe setoso-stipitatis instructo.

CHINA. H u p e h: without precise locality, *A. Henry*, no. 5554a (type of *N. sinensis* var. *glanduligera*). K w e i c h o u: route de Pin-fa à Tou-yun, *J. Cavalerie*, no. 2461, July 1905 (holotype of *N. glandulocalyx*; merotype in A. A.).

This form seems almost as common as the typical form with glabrous calyx and the following specimens are referable to it: S h e n s i: "monte Thae-pei-san," *J. Giraldi*, July 20, 1897; H u p e h: without special locality, *E. H. Wilson*, Veitch Exp. no. 701 in part; (fruiting branch only); Ichang, *E. H. Wilson*, Arnold Arb. Exp. no. 86 in part (fruiting branches only); Hsing-shan hsien, *E. H. Wilson*, no. 189; H u n a n: in monte Yun-schan prope urbem Wukang, *H. Handel-Mazzetti*, no. 12010.

*Spiraea media* Schmidt var. *monbetsusensis* (Franch.) Cardot apud Nakai in Tokyo Bot. Mag. XLII. 464 (1928).

*Spiraea Fauriei* Léveillé in Fedde, Rep. Spec. Nov. VIII. 281 (1910).—  
Synon. nov.

SAGHALIN: in rupibus littoris Kornakoff, *U. Faurie*, no. 575, July 1908 (holotype of *S. Fauriei*; photo. of type and isotype in A. A.).

In a note on the sheet of the type specimen Koidzumi has already identified *S. Fauriei* with *S. monbetsusensis* Franch., and *Faurie* no. 575 is cited by Nakai (l. c.) under the specimens from Korea but the name given by Léveillé is not mentioned.

<sup>1</sup> Continued from vol. XII. 281 (1931); for preceding parts see x. 108-132, 184-196.

*Spiraea Martini* Léveillé in Fedde, Rep. Spec. Nov. ix. 321 (1911); Cat. Pl. Yun-Nan, 244 (1917).—Rehder in Jour. Arnold Arb. 1. 258 (1920).

*Spiraea fulvescens* Rehder in Sargent, Pl. Wilson. 1. 439 (1913).

CHINA. Yunnan: environs de Yun-nan-sen, dans la montagne, ravines, bords de torrents, *E. Bodinier*, no. 89, March 2, 1897 (holotype of *S. Martini*; merotype and photo. in A. A.); Mengtze, barren clay hills; alt. 5000 ft. *A. Henry*, no. 10662 (holotype of *S. fulvescens* in A. A.).

*Spiraea Cavaleriei* Léveillé in Fedde, Rep. Spec. Nov. ix. 321 (1911); Fl. Kouy-Tchéou, 301 (1915).

CHINA. Kweichou: district de Tou-chan, *J. Cavalerie* in herb. Bodinier, no. 2602, March-April 1899 (holotype; photo. in A. A.).

This species is closely related to the preceding and both may be forms of one species. It differs from *S. Martini* in the distinctly ovate leaves rounded at base, crenate and not at all lobed, less glaucous beneath, in the larger inflorescence with about 10 or more flowers and an elongated rhachis about 1 cm. long; in the larger flowers about 8 mm. across, in the slenderer pedicels up to 1.2 cm. long, and in the small leaflets at the base of the inflorescence being absent or reduced to very small bracts.

*Spiraea pubescens* Turczaninow in Bull. Soc. Nat. Moscou, v. 190 (1832).

*Spiraea ouensanensis* Léveillé in Fedde, Rep. Spec. Nov. vii. 197 (1909).—Synon. nov.

KOREA: in montibus Ouen-san, *U. Faurie*, no. 315, July 1906 (holotype of *S. ouensanensis*; photo. and isotype in A. A.).

An isotype of Faurie's no. 315 in this herbarium has the leaves broader and less pubescent and is just past flowering, while the type in the Edinburgh herbarium has leaves more like typical *S. pubescens* and is in fruit. Nakai (Tokyo Bot. Mag. XLII. 465, 466. 1928) distinguishes two forms, var. *lasiocarpa* and var. *leiocarpa*; the former seems to be the more common and *S. ouensanensis* belongs to it.

*Spiraea ovalis* Rehder in Sargent, Pl. Wilson. 1. 446 (1913).

*Spiraea microphylla* Léveillé in Bull. Géog. Bot. xxv. 44 (1915); Cat. Pl. Yun-Nan, 244 (1917).—Synon. nov.

CHINA. Yunnan: rochers des montagnes à Kiao-mé-ti, alt. 3150 m., *E. E. Maire*, May 1912 (holotype of *S. microphylla*; merotype in A. A.).

This species was known so far only from the type specimen collected in Fang Hsien, Western Hupeh.

*Spiraea Veitchii* Hemsley in Gard. Chron. ser. 3, xxxiii. 258 (1903).

*Spiraea atemnophylla* Léveillé in Bull. Géog. Bot. xxv. 44 (1915); Cat. Pl. Yun-Nan, 244 (1917).—*Synon. nov.*

CHINA. Yunnan: rochers des montagnes à Kiao-mé-ti, 3200 m., *E. E. Maire*, Aug. (syntype of *S. atemnophylla*; photo. in A. A.); brousse de mamelon à Ta-hai, *E. E. Maire* (ex Léveillé; syntype of *S. atemnophylla*); pâturages du haut plateau de Ié-ma-tchouan, 3200 m., *E. E. Maire* (ex Léveillé; syntype of *S. atemnophylla*).

This species does not seem to have been recorded from Yunnan before.

*Spiraea Mairei* Léveillé in Bull. Géog. Bot. xxv. 43 (1915); Cat. Pl. Yun-Nan, 244 (1917).

CHINA. Yunnan: brousse des montagnes à Kiao-mé-ti, 3100 m., *E. E. Maire*, May 1912, “arbuste fragile, buissonnant; fleurs blanches” (holotype; merotype in A. A.).

This species is very similar to *S. Teniana* Rehd. in its inflorescence and the shape and serration of the leaves, but differs in the striped or slightly angled villous branchlets, in the leaves being pubescent on both sides with long accumbent hairs, in the longer more villous pubescence of the inflorescence and the pubescent sepals.

*Spiraea japonica* L. f. var. *acuminata* Franchet in Nouv. Arch. Mus. Paris, sér. 2, VIII. 218 (Pl. David. II. 36) (1885).

*Spiraea Bodinieri* Léveillé in Fedde, Rep. Spec. Nov. IX. 322 (1911); Fl. Kouy-Tchéou, 361 (1915).—*Synon. nov.*

*Spiraea Bodinieri* var. *concolor* Léveillé, l. c. (1911).—*Synon. nov.*

*Spiraea Esquirolii* Léveillé, l. c. (1911); l. c. (1915).—*Synon. nov.*

CHINA. Kweichou: Mont du Collège, *E. Bodinier*, July 3, 1900 (syntype of *S. Bodinieri*; photo. in A. A.); environs de Touchan, *J. Cavalerie*, no. 2682, June 1899 (syntype of *S. Bodinieri*); mont de Lou-hong-koan, *E. Bodinier*, no. 1709, June 10 and July 21, 1897 (syntypes of *S. Bodinieri* var. *concolor* photos. in A. A.); Yang-tien, *E. Bodinier*, no. 492, (not 429) July 16, 1900, “arbuste; fleur violacé” (syntype of *S. Esquirolii*; merotype in A. A.).

There is no specimen of *S. Bodinieri* with the data “Mont du Collège, Juillet 3, 1900, E. Bodinier” in the Léveillé herbarium, but by elimination it must be the sheet labeled in Léveillé’s handwriting *Spiraea Bodinieri* without any further data.

*Spiraea Bodinieri* var. *concolor* is not mentioned in Flore de Kouy-Tchéou, but its type number is cited under *S. Bodinieri*; nor does the varietal name appear on his type specimens.<sup>1</sup>

<sup>1</sup> *Spiraea holorhodantha* Léveillé in Bull. Geog. Bot. xxv. 44 (1915) is *Rodgersia pinnata* Franch. as determined by W. Edgar Evans in herb. Edinb.

**Cotoneaster horizontalis** Decaisne in *Fl. des Serres*, xxii. 168 (1877).

*Diospyros Chaffanjoni* Léveillé in Fedde, *Rep. Spec. Nov.* xii. 101 (1913); *Fl. Kouy-Tchéou*, 145 (1914).—*Synon. nov.*

CHINA. Kweichou: Kouy-yang, cascade du Collège, *Chaffanjon*, May 12, 1928 (holotype of *Diospyros Chaffanjoni*; photo. in A. A.).

Léveillé compares his *Diospyros Chaffanjoni* with *D. vacciniooides* Lindl. to which it has a very slight resemblance only in the shape of the leaves, but the latter are considerably larger in *D. vacciniooides*.

**Cotoneaster Franchetii** Bois in *Rev. Hort.* 1902, p. 379, fig. 159–161, 164.

*Cotoneaster Mairei* Léveillé in *Bull. Géog. Bot.* xxv. 45 (1915); *Cat. Pl. Yun-Nan*, 229 (1917).—*Synon. nov.*

*Cotoneaster Mairei* var. *albiflora* Léveillé, l. c.—*Synon. nov.*

CHINA. Yunnan: rochers des montagnes derrière Tongtchouan, 2600 m., *E. E. Maire*, June 1912 (holotype of *C. Mairei*; photo. in A. A.); rochers des collines à Kin-tchong-chan, 2550 m., *E. E. Maire*, May 1912, “arbuste dressé buissonnant; fleurs blanches sur calyx rouge” (holotype of *C. Mairei* var. *albiflora*; merotype in A. A.).

Var. *albiflora* differs only slightly in its smaller leaves and pure white flowers from typical *C. Mairei*; the color of the flowers varies in most species of this group from pure white to more or less flushed with pink in bud and on the back of the petals. The varietal name is not mentioned in the Catalogue des plantes du Yun-Nan and does not appear on the label of the specimen from Kin-tchong-chan.

**Cotoneaster glaucophylla** Franchet, *Pl. Delavay*, 222 (1890).

*Photinia rosifoliolata* Léveillé in *Bull. Géog. Bot.* xxiv. 142 (1914); *Fl. Kouy-Tchéou*, 349 (1915).—*Synon. nov.*

CHINA. Kweichou: Tin-fan, *J. Cavalerie*, no. 3838, June 1909, “fleurs blanches” (holotype of *Photinia rosifoliolata*; merotype in A. A.).<sup>1</sup>

**Crataegus scabrifolia** (Franch.) Rehder in *Jour. Arnold Arb.* xii. 71 (1931).

*Crataegus Henryi* Dunn in *Jour. Linn. Soc.* xxxv. 494 (1903).

*Crataegus Bodinieri* Léveillé in *Bull. Soc. Bot. France*, lv. 57 (1908).—*Synon. nov.*

CHINA. Yunnan: montagnes entre Ma-kay et Se-tsong-chou, *E. Bodinier*, April 4, 1897 (holotype of *C. Bodinieri*; merotype

<sup>1</sup> *Cotoneaster Blinii* Léveillé (Cat. Pl. Yun-Nan, 229. 1917) and *C. Esquirolii* Léveillé (Fl. Kouy-Tchéou, 345. 1915) do not belong to *Cotoneaster*, but the incomplete material does not allow to place them definitively. They may be conspecific and belong to the Pomoideae, resembling somewhat *Photinia* or *Stranvaesia*, but differing from them in the structure of the fruit, immature in *C. Esquirolii*.

in A. A.); Ma-chou, alt. 3000 m., *E. E. Maire*, April 1911-13 (in herb. Léveillé sub *C. Bodinieri*).

Both specimens are in bloom, while the type of Franchet's *Pirus scabrifolia* is in fruit.

**Crataegus cuneata** Siebold & Zuccarini in Abh. Akad. Münch. 2, iv. 130 (Fl. Jap. Fam. Nat. 1. 22) (1846).

*Crataegus Argyi* Léveillé & Vaniot in Bull. Soc. Bot. France, LV. 57 (1908).—Léveillé in Mem. Acad. Ci. Art. Barcelona, ser. 3, XII. no. 22, p. 19 (1916).

*Crataegus stephanostyla* Léveillé & Vaniot, l. c. (1908).—Léveillé, l. c. (1916).

*Crataegus Chantcha* Léveillé in Fedde, Rep. Spec. Nov. x. 377 (1912); Fl. Kouy-Tchéou, 346 (1915).

CHINA. Kiangsu: Chang-li-hong, Chang-sun, Vou-né, *Ch. d'Argy* [1846-66] (holotype of *C. Argyi*; photo in A. A.); Si-tcha-chun, Si-souo-se; Zi-se, montagnes, *Ch. d'Argy*, May 15 [1846-66] (holotype of *C. stephanostyla*); merotype in A. A.). Kwei-chou: environs de Gan-pin, *E. Bodinier*, April 29, 1897 (holotype of *C. Chantcha*; photo. in A. A.).

The specimens of *C. stephanostyla* and *C. Chantcha* are in bloom and that of *C. Argyi* is in fruit. All three represent undoubtedly the widely distributed and characteristic *C. cuneata* Sieb. & Zucc.

**Crataegus pinnatifida** Bunge in Mém. Acad. Sci. St. Pétersb. II. 100 (Enum. Pl. Chin. Bor. 26) (1831).

*Crataegus coreanus* Léveillé in Fedde, Rep. Spec. Nov. VII. 197 (1909).

*Crataegus pinnatifida* Bge. var. *psilosa* Schneider in Ill. Handb. Laubholzk. I. 769 (1906).—Nakai, Fl. Sylv. Kor. VI. 59, t. 26, fig. a (1916).

KOREA: circa Seoul communis, *U. Faurie*, no. 307, June 1906, and circa Chinnampo, *U. Faurie*, no. 308, Sept. 1906 (syntypes of *C. coreanus*; isotypes and merotype in A. A.).

*Crataegus coreanus* has been already identified by Nakai (l. c.) with *C. pinnatifida* var. *psilosa* Schneid., but this identification is true only as far as it concerns Faurie's no. 307, while no. 308 which is in fruit belongs to the typical form (var. *typica* Schneid. l. c.). The two forms differ only in their glabrous or pubescent inflorescence; they are hardly of varietal rank and do not occupy distinct geographical ranges.

**Sorbus Koehneana** Schneider in Bull. Herb. Boissier, sér. 2, VI. 316 (1906).

*Sorbus Valbrayi* Léveillé in Monde Pl. sér. 2, XVIII. 28 (1916); Cat. Pl. Yun-Nan, 242, fig. 62 (1917).—**Synon. nov.**

CHINA. Yunnan: plateau du Io-chan, 3400 m., *E. E. Maire*, June 1912, "grand arbuste rameux" (holotype of *S. Valbrayi*).

**Sorbus Keissleri** (Schneid.) Rehder in Sargent, Pl. Wilson. II. 269 (1915).

*Sorbus Mairei* Rehder & Léveillé apud Léveillé, Cat. Pl. Yun-Nan, 242 (1917), nomen.—**Synon. nov.**

*Sorbus Aria* var. *Mairei* Léveillé, Cat. Pl. Yun-Nan, 242 (1917), pro synon. *Sorbi Mairei*.

CHINA. Yunnan: rochers des montagnes à Kiao-mé-ti, alt. 3100 m., *E. E. Maire*, “arbuste buissonnant, haut 1 m. ou 2 m.” (holotype of *S. Aria* var. *Mairei*; photo. in A. A.).

Léveillé cites (l. c.) “*S. Aria* Crantz var. *Mairei* Lévl. in Fedde Rep. III. 341,” but neither there nor elsewhere did I find this name, though it appears on the label of the type specimen. I may have written to Léveillé with whom I corresponded at that time, that his *Sorbus Aria* var. *Mairei* did not belong to *S. Aria*, but I had no part in making the combination *S. Mairei*.

**Sorbus Hemsleyi** (Schneid.) Rehder in Sargent, Pl. Wilson. II. 276 (1915).

*Pirus Koehnei* Léveillé in Fedde, Rep. Spec. Nov. x. 378 (1912); Fl. Kouy-Tchéou, 351 (1915); non *Pyrus Koehnei* Schneid. (1906).—**Synon. nov.**

CHINA. Kweichou: Pin-fa, montagnes, *J. Cavalerie*, no. 2376, June 15, 1905 (ex Léveillé; syntype of *Pirus Kochnei*); *J. Esquirol*, no. 385 (syntype of *Pirus Koehnei*; photo. in A. A.).

**Photinia villosa** (Thbg.) De Candolle, Prodr. II. 631 (1825).

*Pirus brunnea* Léveillé in Fedde, Rep. Spec. Nov. x. 377 (1912).—Rehder in Sargent, Pl. Wilson. II. 300 (1915).

*Pirus sinensis* Lindl. var. *Maximowicziana* Léveillé l. c. (1912).—Rehder, l. c. (1915).—**Synon. nov.**

*Pirus spectabilis* Ait. var. *albescens* Léveillé, l. c. (1912).—Rehder, l. c. (1915).

*Pourthiae villosa* (Thbg.) Decne. var. *typica* (Schneid.) Nakai, Fl. Sylv. Kor. vi. 28 (1916).

*Pourthiae villosa* var. *brunnea* (Lévl.) Nakai l. c. 29, t. 7 (1916).

KOREA. Quelpaert: in silvis Hallaisan, 800 m., *E. Taquet*, no. 2819, Oct. 1909 (holotype of *Pirus brunnea*; merotype and isotype in A. A.); in silvis Haitchenam [?], *E. Taquet*, no. 2821, Aug. 1909 (holotype of *Pirus sinensis* var. *Maximowicziana*; photo. and isotype in A. A.); in silvis Hallaisan, 900 m., *E. Taquet*, no. 2815, June 1909 (holotype of *Pirus spectabilis* var. *albescens*; photo. and isotype in A. A.).

*Pirus brunnea* does not seem to be sufficiently different from typical *Photinia villosa* to consider it a distinct variety as done by Nakai, while he refers *Pirus spectabilis* var. *albescens* to his *Pourthiae villosa* var. *typica*. *Pirus sinensis* var. *Maximowicziana* he does not mention. The latter species and *P. brunnea* are represented by fruiting specimens; *P. spectabilis* var. *albescens* is in bloom.

**Photinia villosa** var. **coreana** (Decne.) Rehder in Jour. Arnold Arb. II. 45 (1920).

*Pirus mokpoensis* Léveillé in Fedde, Rep. Spec. Nov. VII. 200 (1909).

*Pourthiae villosa* var. **coreana** (Decne.) Nakai, Fl. Sylv. Kor. VI. 29 (1916).

KOREA: circa Mokpo, *U. Faurie*, no. 1556, May 1907 (holotype of *Pirus mokpoensis*; isotype in Herb. Arnold Arb.).

*Pirus mokpoensis* was first identified with *Photinia villosa* var. **coreana** by Nakai.

**Photinia Beauverdiana** Schneider in Bull. Herb. Boiss. sér. 2, VI. 319 (1906).

*Photinia Cavaleriei* Léveillé in Fedde, Rep. Spec. Nov. IV. 334 (1907); Fl. Kouy-Tchéou, 349 (1915).—**Synon. nov.**

CHINA. Kweichou: Ly-po, *J. Cavalerie*, no. 2631, May 1899 (holotype of *P. Cavaleriei*; photo. in A. A.).

**Photinia parvifolia** Schneider, Ill. Handb. Laubholzk. I. 711, fig. 392 0-0' (1906).

*Photinia subumbellata* Rehder & Wilson in Sargent, Pl. Wilson. I. 189 (1912).—**Synon. nov.**

*Crataegus Cavaleriei* Léveillé, Fl. Kouy-Tchéou, 346 (1915), quoad specimen cit. 1303; non Léveillé & Vaniot (1908).

*Viburnum Komarovii* Léveillé & Vaniot in Fedde, Rep. Spec. Nov. IX. 78 (1910); Fl. Kouy-Tchéou, 66 (1914).—**Synon. nov.**

CHINA. Kweichou: Pin-fa, montagne, *J. Cavalerie*, no. 1303, May 3, 1902 (? paratype of *Viburnum Komarovii*; photo. in A. A.); Ma-jo, *J. Cavalerie*, no. 1303, Oct. 1908 (holotype of *Viburnum Komarovii*; merotype in A. A.); no. 1892, Sept. 1903 (ex Léveillé, Fl. Kouy-Tchéou).

There seems to be considerable confusion in Léveillé's numbers. In Léveillé's herbarium in the cover of *Crataegus Cavaleriei* there is a flowering specimen from Pin-fa, May 3, 1902, with the original number 93 crossed out and 1303 written over it, but the fruiting specimen under no. 93 upon which Léveillé's description is based belongs to *Malus Sieboldii* (Rgl.) Rehd. As *Viburnum Komarovii* Léveillé describes (l. c.) under no. 1303 flowering and fruiting specimens, though he gives only October 1908 as collecting date under the original description, but in the Flore du Kouy-Tchéou he cites an additional number 1892, Sept. 1903, from Pin-fa which I have not seen. Apparently the flowering specimen in the cover of *Crataegus Cavaleriei* is the flowering specimen described, but not cited under *Viburnum Komarovii*; no reference to a specimen collected May 3, 1902 appears under *Crataegus Cavaleriei* or *Viburnum Komarovii*.

With the abundant material now at hand I cannot find that *P. subumbellata* Rehd. & Wils. is sufficiently distinct from *P. parvi-*

*folia* to be maintained as a species, since the extreme forms are connected by intermediate specimens which makes it difficult to separate clearly the two groups.

**Photinia amphidoxa** (Schneid.) Rehder & Wilson in Sargent, Pl. Wilson. I. 190 (1912).

*Pirus Feddei* Léveillé in Fedde, Rep. Spec. Nov. XII. 189 (1913); Fl. Kouy-Tchéou, 350 (1915).

CHINA. Kweichou: Pin-fa, *J. Cavalerie*, no. 2533, Oct. 11, 1905 (holotype of *Pirus Feddei*; photo. in A. A.).

**Photinia crassifolia** Léveillé, Fl. Kouy-Tchéou, 349 (1915), nomen seminudum.—Cardot in Bull. Mus. Nat. Hist. Paris, XXV. 398 (1919).

*Photinia Cavaleriei* Léveillé in Fedde, Rep. Spec. Nov. XI. 66 (1912); non Léveillé (1907).

*Photinia crassifolia* Levl. var. *denticulata* Cardot in Lecomte, Not. Syst. III. 372 (1918).

CHINA. Kweichou: Tin-fan, *J. Cavalerie*, no. 3571 (in part) June 1909 (holotype of *P. Cavaleriei*; merotype in A. A.); Gan-chouen, *J. Cavalerie*, no. 3571 (in part) April 1912 (paratype of *P. crassifolia*; merotype in A. A.).

This species was first published as *P. Cavaleriei* based on a specimen collected at Tin-fan in 1909 by Cavalerie and numbered 3571; in 1915 Léveillé enumerates under the name *P. crassifolia* the preceding specimen with the addition of a specimen from Gan-chouen collected in 1912 and also numbered 3571, but without reference to the previous name and description. The species varies in the pubescence of the inflorescence and in the denticulation of the leaves; in the specimen from Tin-fan the inflorescence is densely villous except the calyx, and the leaves are practically entire while in a flowering specimen from Gan-chouen the inflorescence is nearly glabrous, though the base of the peduncle and the branchlets are densely villous, and the leaves are entire, but are distinctly denticulate in a specimen from the same locality with an old densely villous inflorescence. The latter apparently is the specimen upon which Cardot based his var. *denticulata*, while the flowering specimen may be of the collection of 1910 also from Gan-chouen mentioned by him, but not referred to by Léveillé.

**Photinia serrulata** Lindley in Trans. Linn. Soc. XIII. 103 (1821), excl. syn. *Crataegus glabra* Thbg.

*Stranvaesia Argyi* Léveillé in Mem. Acad. Ci. Art. Barcelona, ser. 3, XII. 560 (Cat. Pl. Kiang-Sou, 20) (1916), pro synon. *S. Calleryanae* Dene.

CHINA. Kiangsu: without locality, *Ch. d'Argy* [1848-66] (holotype of *Stranvaesia Argyi*; photo. in A. A.).

*Stranvaesia Argyi* seems to be only an herbarium name given by Léveillé to a specimen without any other data except Léveillé's label "Stranvaesia Argyi Lévl." He published it later erroneously as a synonym of *S. Calleryana*.

**Photinia Bodinieri** Léveillé in Fedde, Rep. Spec. Nov. IV. 334 (1907).—Cardot in Bull. Mus. Nat. Hist. Paris, xxv. 402 (1919).

*Hiptage Esquirolii* Léveillé in Fedde, Rep. Spec. Nov. x. 372 (1912); Fl. Kouy-Tchéou, 271 (1914).—*Synon. nov.*

*Photinia serrulata* Léveillé, Fl. Kouy-Tchéou, 349 (1915), quoad synon. et specimen cit. no. 2256.—Non Lindley.

CHINA. Kweichou: environs de Kouy-yang, mont. du Collège, E. Bodinier, no. 2256, May 18, 1898 (holotype of *Photinia Bodinieri*; photo. in A. A.); Chouï-t'eu, route de Tin-fan à Lo-fou, alt. 900 m., J. Esquirol, no. 2097, May 4, 1900 (bel arbre, fleurs blanches; holotype of *Hiptage Esquirolii*; merotype in A. A.).

In his Flore du Kouy-Tchéou Léveillé refers his *Photinia Bodinieri* to *P. serrulata* Lindl., but as Cardot (l. c.) points out, *P. Bodinieri* can be readily distinguished by the larger flowers and the more connate styles.

**Photinia Mairei** Léveillé in Monde des Pl. ser. 2, xviii. 28 (1916); Cat. Pl. Yun-Nan, 230 (1917).

CHINA. Yunnan: rochers, brousse des montagnes à Kiao-méti, 3100 m., E. E. Maire, May 1912 (holotype; merotype in A. A.).

Of this plant I have before me a rather meagre specimen with a small crowded paniculate inflorescence not leafy at base; the leaves are elliptic-obovate, crenate-serrulate and 6–7 cm. long. The inflorescence recalls that of *Eriobotrya*, but the nearly superior ovary removes it from that genus. I do not know any species either in *Eriobotrya* or in *Photinia* with which it could be compared.

**Stranvaesia Davidiana** Decaisne in Nouv. Arch. Mus. Paris, x. 179 (1874).

*Pirus Cavaleriei* Léveillé in Fedde Rep. Spec. Nov. xi. 66 (1912); Fl. Kouy-Tchéou, 350 (1915).—*Synon. nov.*

CHINA. Kweichou: Pin-fa, J. Cavalerie, no. 3569, Oct. 1908 (holotype of *Pirus Cavaleriei*; merotype in A. A.).

**Eriobotrya Cavaleriei** (Lévl.), comb. nov.

*Hiptage Cavaleriei* Léveillé in Fedde, Rep. Spec. Nov. x. 372 (1912); Fl. Kouy-Tchéou, 271 (1914).

*Eriobotrya Bracklei* Hand.-Mazz. var. *atrichophylla* Handel-Mazzetti in Anz. Akad. Wiss. Wien Math. Naturw. Kl. 1922, no. 12, p. 103 (Pl. Nov. Sin. Forts. 16, p. 2) (1922).—*Synon. nov.*

CHINA. Kweichou: Pin-fa, montagne en pente, J. Cavalerie, no. 3220 May 20, 1907 (arbre de 9 m. de hauteur; fl. blanches odor; holotype of *Hiptage Cavaleriei*; merotype in A. A.).

In the original place of publication the citation of specimen and locality is lacking, but is given in *Flore du Kouy-Tchéou* (l. c.).

As *Eriobotrya Brackloii* var. *atrichophylla* Hand.-Mazz. becomes a synonym of *E. Cavaleriei* (Lévl.), typical *E. Brackloii* must be considered a variety of that species and should bear the name *Eriobotrya Cavaleriei* var. *Brackloii* (Hand.-Mazz.), new comb. (*E. Brackloii* Handel-Mazzetti in *Anz. Akad. Wiss. Wien Math.-Naturw. Kl.* 1922, no. 12, p. 102 [*Pl. Nov. Sin. Forts.* 16, p. 2] [1922]).

*Eriobotrya Seguini* (Lévl.) Cardot apud Guillaumin in *Bull. Soc. Bot. France*, **LXXI**, 287 (1924), "Seguinii."

*Symplocos Seguini* Léveillé in Fedde, *Rep. Spec. Nov.* x. 431 (1912); Fl. Kouy-Tchéou, 408 (1915).

*Eriobotrya pseudo-Raphiolepis* Cardot in Lecomte, *Not. Syst.* III. 371 (1918).

CHINA. Kweichou: environs de Ou-la-gay et de Hoang-kochou, *J. Seguin* in herb. Bodinier, nos. 2262, April 1898, and 2617, March 1, 1899 (syntypes of *Symplocos Seguini* [in herb. Edinb.] and of *Eriobotrya pseudo-Raphiolepis* [in herb. Paris]; photo. and fragments of no. 2617 [herb. Edinb.] in A. A.).

This species was first described by Léveillé as *Symplocos Seguini*, but the herbarium specimens bear the name *Lindera Seguini* Lévl. in his own handwriting. On duplicates of the same numbers in the Paris Herbarium Cardot based his *E. pseudo-Raphiolepis*. The connection was discovered when Guillaumin writing his paper "Observations sur les *Symplocos* d'Extrême-Orient" examined the type specimen of *Symplocos Seguini* and found that it was not a *Symplocos*, but an *Eriobotrya*.

*Amelanchier asiatica* (Sieb. & Zucc.) Endlicher apud Walpers, *Rep.* II. 55 (1843).—Nakai, Fl. *Sylv. Kor.* VI. 19, t. 1 (1916).

*Pirus Taqueti* Léveillé in Fedde, *Rep. Spec. Nov.* VII. 199 (1909).

*Pirus Vanioti* Léveillé, op. cit. 200 (1909).

KOREA: Hallaisan, in silvis, *U. Faurie*, nos. 1559, 1560 (ex Léveillé), 1561, May to July 1907 (syntypes of *Pirus Taqueti*; isotype of no. 1561 in A. A.); same locality, *E. Taqueti*, no. 103, Oct. 1907 (syntype of *P. Taqueti*); Quelpaert, in silvis, *U. Faurie*, no. 1557, May 1907 (holotype of *Pirus Vanioti*; isotype in herb. A. A.).

*Pirus Taqueti* and *P. Vanioti* had already been identified with *Amelanchier asiatica* by Nakai (l. c.).

*Malus Sieboldii* (Reg.) Rehder in Sargent, *Pl. Wilson.* II. 293 (1915).

*Crataegus Cavaleriei* Léveillé & Vaniot in Bull. Soc. Bot. France, lv. 58 (1908); Fl. Kouy-Tchéou, 346 (1915), excl. no. cit. 1303.—*Synon. nov.*

*Pirus subcrataegifolia* Léveillé in Fedde, Rep. Spec. Nov. vii. 199 (1909).  
*Photinia rubro-lutea* Léveillé in Fedde, Rep. Spec. Nov. ix. 460 (1911);  
 Fl. Kouy-Tchéou, 349 (1915).—*Synon. nov.*

*Crataegus Taquetii* Léveillé in Fedde, Rep. Spec. Nov. x. 377 (1912).—  
*Synon. nov.*

*Pirus Esquirolii* Léveillé in Fedde, Rep. Spec. Nov. xii. 189 (1913);  
 Fl. Kouy-Tchéou, 350 (1915).—*Synon. nov.*

*Malus Toringo* Siebold, Cat. Rais. i. 4 (1856), nomen.—*Nakai*, Fl. Sylv. Kor. vi. 35, t. 10 (1916).

**KOREA.** Quelpaert: Hallaisan, U. Faurie, no. 1558, June 1907 (holotype of *Pirus subcrataegifolia* and syntype of *Crataegus Taquetii*); in silvis Hallaisan, 900 m., E. Taquet, no. 2828, Oct. 1909 (syntype of *Crataegus Taquetii*; isotype in A. A.); in silvis Yengsil, 1000 m., E. Taquet, no. 4220, Aug. 12, 1910 (syntype of *Crataegus Taquetii*; isotype in A. A.).

**CHINA.** Kweichou: Pin-fa, montagne, *J. Cavalerie*, no. 93, July 23, 1902 (holotype of *Crataegus Cavaleriei*; photo. in A. A.); same locality, *J. Cavalerie*, no. 1304, April 2, 1902 (holotype of *Pirus Esquirolii*; photo. in A. A.); without locality, *J. Cavalerie*, no. 3303, Nov. 13, 1907 (holotype of *Photinia rubro-lutea*; merotype in A. A.).

*Malus Sieboldii* seems to be widely distributed in southeastern China, ranging west to Kweichou, as the following additional specimens in the herbarium of the Arnold Arboretum show: Chekiang (N. T. Liou, no. 442), Kiangsi (H. H. Hu, no. 943), Kwangtung (Y. Tsiang, no. 1381), Kwangsi (R. C. Ching, no. 5935), Hunan (Handel-Mazzetti, no. 11787, Pl. Sin. cur. Handel-Mazzetti, no. 94) and Kweichou (Handel-Mazzetti, no. 285, Y. Tsiang, nos. 5006 and 5521). The species does not seem to occur in northern China and its Chinese area shows no connection with the range of the species in Korea and Japan, but I can see no marked difference between the plants of the two areas and have to consider them conspecific in spite of their geographical separation.

**Docynia Delavayi** (Franch.) Schneider in Fedde, Rep. Spec. Nov. iii. 180 (1906).

*Cotoneaster Bodinieri* Léveillé in Bull. Géog. Bot. xxv. 44 (1915);  
 Cat. Pl. Yun-Nan, 229 (1917).—*Synon. nov.*

**CHINA.** Yunnan: près de la frontière de Kouy-Tchéou à Kiang-ti, E. Bodinier, April 9, 1897 (holotype of *Cotoneaster Bodinieri*; photo. and fragments in A. A.).

*Cotoneaster Bodinieri* was first identified with *D. Delavayi* by H. E. Evans according to a note on the type specimen.

***Docynia rufifolia* (Lévl.), comb. nov.**

*Pirus (Cydonia) rufifolia* Léveillé in Bull. Géog. Bot. xxv. 46 (1915); Cat. Pl. Yun-Nan, 231 (1917), sphalmate "rufifolia." *Mahus docynoides* Schneider in Bot. Gaz. LXIII. 400 (1917).—Synon. nov.

*Docynia docynioides* (Schneid.) Rehder in Jour. Arnold Arb. II. 58 (1920).

CHINA. Yunnan: flanc des coteaux arides à Lou-pou, 3050 m., *E. E. Maire*, June 1912, "fleurs blanches; fruits jaunes, oblong" (type of *P. rufifolia*; merotype in A. A.).

***Pyrus Calleryana* Decaisne, Jard. Fruit. I. in textu ad t. 8 (1872).**

*Pirus Mairei* Léveillé in Fedde, Rep. Spec. Nov. XII. 189 (1913); Cat. Pl. Yun-Nan, 231 (1917).

CHINA. Yunnan: Tche-hay, haies de la plaine, 2500 m., *E. E. Maire*, March 1911 (holotype of *Pirus Mairei*; merotype in A. A.).

***Rosa multiflora* Thbg. var. *adenophora*** Franchet & Savatier, Enum. Pl. Jap. I. 134 (1875), nomen; II. 345 (1879).—Nakai, Fl. Sylv. Kor. VII. 30, t. 5 (1918).

*Rosa Nakaiana* Léveillé in Fedde, Rep. Spec. Nov. X. 432 (1912).

KOREA: "Corea media" *U. Faurie*, no. 330, July 1906 (holotype of *R. Nakaiana*; photo. in A. A.).

***Rosa multiflora* var. *quelpaertensis*** (Lévl.) Rehder & Wilson in Sargent, Pl. Wilson. II. 335 (1915).

*Rosa mokanensis* Léveillé in Fedde, Rep. Spec. Nov. VII. 340 (1909), pro parte typica.—Willmott, Gen. Rosa, II. 511, t. (1914).

*Rosa quelpaertensis* Léveillé in Fedde, Rep. Spec. Nov. X. 378 (1912).

*Rosa mokanensis* var. *quelpaertensis* Willmott, Gen. Rosa, II. 512, t. (1914).

*Rosa multiflora* var. *microphylla* Nakai, Fl. Sylv. Kor. VII. 30 (1918), pro parte.—Non Franchet & Savatier.

KOREA. Quelpaert: Mokan, *E. Taquet*, no. 778, June 8, 1908 (in part; syntype of *R. mokanensis*; photo. and isotype in A. A.); in sepibus Hogno, *E. Taquet*, no. 2870, May 1909 (holotype of *R. quelpaertensis*; isotype in A. A.); in petrosis secus vias, *U. Faurie*, no. 1567, May 1907; in sepibus, *E. Taquet*, no. 5587, June 1911; Hoatien, *E. Taquet*, no. 5590, June 1911 (nos. 1567, 5587 and 5590 in herb. Léveillé sub *R. quelpaertensis*).

The type specimens of *R. mokanensis* consists of two branches, one representing *R. multiflora* and one *R. Wichuraiana*; the former must be considered the type of *R. mokanensis*, as the character "pedunculis glandulosis" applies only to this form.

Nakai refers *R. quelpaertensis* to *R. multiflora* var. *microphylla* Franch. & Savatier, but this variety is described as having ovate leaflets not cuneate at base, while in var. *quelpaertensis* the leaflets are generally obovate and cuneate.

**Rosa multiflora** var. *cathayensis* Rehder & Wilson in Sargent, Pl. Wilson. II. 304 (1915).

*Rosa macrophylla* var. *hypoleuca* Léveillé, Fl. Kouy-Tchéou, 354 (1915), nomen.

CHINA. Kweichou: Gan-chouen, commune, *J. Cavalerie*, no. 3953, "fl. blanches" (holotype of *R. macrophylla* var. *hypoleuca*; photo. in A. A.). Yunnan: haies, plaine de Long-tou, alt. 2400 m., *E. E. Maire*, "fl. rosées" (as *R. clavigera* forma in herb. Léveillé; photo. in A. A.).

The flowers are white according to the collector and borne in few-flowered corymbs; the leaflets are rather small and densely grayish pubescent beneath, but not whitish as the name seems to imply. Another specimen collected by Bodinier in 1888 on the "Pehoō chan" and named *R. macrophylla* var. *hypoleuca* in Léveillé's herbarium but not in his handwriting belongs to *R. Sweginzowii* Koehne or a related species.

**Rosa multiflora** var. *carnea* Thory in Redouté, Roses, II. 67, t. (1821).—Rehder & Wilson in Sargent, Pl. Wilson. II. 305 (1915).—Byhouwer in Jour. Arnold Arb. x. 86 (1929).

*Rosa Lebrunei* Léveillé in Bull. Géog. Bot. xxv. 46 (1915); Cat. Pl. Yun-Nan, 235 (1917).

*Rosa Blinii* Léveillé, l. c. (1915); l. c. 234 (1917).

CHINA. Yunnan: haies, plaine de La-kou, alt. 2400 m., *E. E. Maire*, May [1910–14], "épineux, buissonant, haut 0.80 m.; fl. doubles, roses ou rouges, inodores" (holotype of *R. Lebrunei*; photo. in A. A.); haies de la plaine à Tong-tchouan, alt. 2500 m., *E. E. Maire*; Mai 1910–14 "petit rosier, épineux, fl. rouges, abondantes par bouquets" (type of *R. Blinii*; photo. in A. A.)

**Rosa Wichuraiana** Crépin in Bull. Soc. Bot. Belg. xxv. 189 (1886).—Rehder & Wilson in Sargent, Pl. Wilson. II. 335 (1915).

*Rosa Luciaé* Franchet & Rochebrune apud Crépin in Bull. Soc. Bot. Belg. x. 323 (1871), pro parte.—Nakai, Fl. Sylv. Kor. VII. 28, t. 2 (1918), pro parte.

*Rosa Taquetii* Léveillé in Fedde, Rep. Spec. Nov. VII. 199 (1909), pro parte typica.

*Rosa mokanensis* Léveillé in Fedde, Rep. Spec. Nov. VII. 340 (1909), pro parte.

*Rosa acicularis* var. *Taquetii* Nakai in Tokyo Bot. Mag. XXX. 241 (1916) et Fl. Sylv. Kor. VII. 38 (1918), tantum quoad synon. citatum.

KOREA. Quelpaert: Hallaisan, *E. Taquet*, no. 102, October 1907 (in part, as to fruiting specimen; syntype of *R. Taquetii*; photo. in A. A.); Mokan, *E. Taquet*, no. 778, June 8, 1908 (in part; syntype of *R. mokanensis*; photo. in A. A.); Moktjafang [?], *E. Taquet*, no. 5586, Aug. 25, 1911 (as *R. Mokanensis* in herb. Léveillé); in sepibus, *E. Taquet*, nos. 5588, 5589, May 1911 (as *R. Fauriei* Lévl. in herb. Léveillé).

The type specimen of *R. Taquetti* consists of two branches, one belonging to *R. Wichuraiana* and one to *R. acicularis*; according to the description "stipulae . . . margine glanduloso-fimbriatae; inflorescentia spicata flexuosa; fructus rubri, globosi, ut pedicelli glandulosi; styli hirti, columnares" the branch of *R. Wichuraiana* should be considered the type. The type specimen of *R. mokanensis* also consists of two branches, of which, as shown under *R. multiflora* var. *quelpaertensis*, that representing var. *quelpaertensis* must be considered the type; the other specimen is an unusually small-leaved form of *R. Wichuraiana*. Taquet's nos. 5588 and 5589 are named *R. Fauriei* Lévl. in Léveillé's handwriting, but the type of that species belongs to *R. Maximowicziana* Regel. and the paratype to *R. acicularis* Lindl.

Nakai refers *R. Wichuraiana* as a synonym to *R. Luciae* Franch. & Rochebr., which, though very closely related, may be distinguished by its more upright habit, thinner and narrower, usually acute, mostly 7 leaflets and smaller flowers.

**Rosa Maximowicziana** Regel in Act. Hort. Petrop. v. 295, 378 (1878).—Nakai, Fl. Sylv. Kor. VII. 26, t. 1 (1918).

*Rosa Fauriei* Léveillé in Fedde, Rep. Spec. Nov. VII. 199 (1909), excl. specimine Fauriei, no. 99.

**KOREA:** Ouen-san, U. Faurie, no. 328, July 1906 (syntype of *R. Fauriei*; photo. in A. A.).

The description of *R. Fauriei* is based almost exclusively on Faurie's no. 328 which is the first specimen enumerated, and constitutes the type of species; from the second specimen, Faurie's no. 99, only the description of the fruit was drawn and this specimen belongs to *R. acicularis* Lindl. The name *R. Fauriei* does not appear on Faurie's no. 328 in the herbarium of Léveillé.

**Rosa Brunonii** Lindley, Ros. Monog. 120, t. 14 (1820).—Byhouwer in Jour. Arnold Arb. x. 87 (1929).

*Rosa clavigera* Léveillé in Fedde, Rep. Spec. Nov. XIII. 338 (1914); Cat. Pl. Yun-Nan, 234 (1917).

**CHINA.** Yunnan: haies, plaine de Long-tan, alt. 2500 m., E. E. Maire, May [1910-14] "grand rosier; feuilles vert luisant, pubescentes au dessous; fl. blanches" (holotype of *R. clavigera*; photo. in A. A.).

**Rosa Rubus** Léveillé & Vaniot in Bull. Soc. Bot. France, LV. 55 (1908).—Willmott, Gen. Rosa, II. 507 (1914).—Léveillé, Fl. Kouy-Tchéou, 354 (1915).—Byhouwer in Jour. Arnold Arb. x. 90 (1929).

*Rosa Rubus* var. *yunnanensis* Léveillé in Bull. Soc. Bot. France, LV. 55 (1908); Cat. Pl. Yun-Nan, 235 (1917).

CHINA. Kweichou: route de Pin-yang, *L. Martin* in herb. Bodinier, no. 2603, May 12, 1899, (holotype of *R. Rubus*; photo. in A. A.). Yunnan: montagnes, an bord de la plaine de Lo-pintchou, *E. Bodinier*, no. 2603,<sup>1</sup> April 6, 1897, "branches sarmenses" (holotype of *R. Rubus* var. *yunnanensis*; photo. and merotype in A. A.).

The original labels in Léveillé's herbarium of *R. Rubus* and *R. Rubus* var. *yunnanensis* seem to have been interchanged; they do not bear Léveillé's names which are on separate slips in Léveillé's handwriting, but the name *R. Rubus* var. *yunnanensis* does not appear at all on the specimen; instead a slip with the name *R. Bodinieri*, a species identical with *R. microcarpa* Lindl., has been pasted by mistake on that sheet. The specimen with the label of Bodinier's no. 2603 agrees with the description of var. *yunnanensis* in the characters "petala apice rotundata; folia utrinque viridia, argute dentata," while the sheet with Bodinier's label of the Yunnan specimen contains the plant which has crenate-serrate leaflets grayish beneath and emarginate petals, all characters given by Léveillé for typical *R. Rubus*. To the Arnold Arboretum Léveillé had sent in 1915 as *R. Rubus* a specimen which agrees with *R. Rubus yunnanensis*; this shows that even at that time confusion existed or that Léveillé having more material of var. *yunnanensis* sent a specimen of the variety instead of the type.

*Rosa Gentiliana* Léveillé & Vaniot in Bull. Soc. Bot. France, LV. 55 (1908).—Willmott, Gen. Rosa, II. 513, t. (1914).—Rehder & Wilson in Sargent, Pl. Wilson. II. 312 (1915).—Léveillé in Mem. Acad. Ci. Art. Barcelona, ser. 3, XII. no. 22, p. 20 (Cat. Pl. Kiang-Sou); Cat. Ill. Seu-Tchouen, 164, t. 59 (1918).

CHINA. Kiangsu: without precise locality, *Ch. d'Argy* [1846-66]; (holotype; fragments in A. A.).

The two illustrations cited above are obviously based on the same specimen which apparently is the type, but does not seem to be in Léveillé's herbarium now.

I have seen no material of this species except some fragments sent by Léveillé in 1915 to the Arnold Arboretum.<sup>2</sup> The species is widely distributed in eastern and Central China, but the peculiar shape of the leaflets stressed by Léveillé represents apparently an aberrant form not constant for the species.

<sup>1</sup> This number in pencil in Léveillé's, not in Bodinier's, handwriting.

<sup>2</sup> The type specimen of this species, of *R. Rubus*, *R. adenoclada* and possibly of some other species are not now in the Herbarium Léveillé; they were loaned to Miss Willmott when she was preparing her work THE GENUS ROSA and probably became separated from Léveillé's collection.

*Rosa adenoclada* Léveillé in Fedde, Rep. Spec. Nov. x. 431 (1912); Fl. Kouy-Tchéou, 353 (1915).—Willmott, Gen. Rosa, II. 517, t. (1914).

*Rosa Gentiliana* Rehder & Wilson in Sargent, Pl. Wilson. II. 312 (1915) quoad syn. *R. adenoclada*.—Non Léveillé.

*Rosa Gentiliana* var. *adenoclada* Léveillé, Cat. Pl. Yun-Nan, 234 (1917), nomen.

CHINA. Kweichou: Grotte de Gai-kio, *J. Esquirol*, no. 2100, May 3, 1910 “couleur rouge” (holotype).

The material of this species in Léveillé's herbarium is very meagre consisting of a single leaf, a piece of a leafless branch and some detached flowers and leaflets, but there is a good figure of a flowering branch in Miss Willmott's book. It is a very puzzling Rose and apparently does not belong to *R. Gentiliana* where it was placed by my former colleague, Mr. Wilson, and myself. It differs from that species in the pilose, more or less free styles, in the red color of the flowers and in the slightly bristly and stipitate-glandular branch. It may possibly be a hybrid of *R. Rubus* Lévl. and *R. chinensis* which would account for the color of the flowers and the character of the styles. It is also somewhat similar to *R. lucidissima* Lévl.

*Rosa longicuspis* A. Bertoloni in Mem. Accad. Sci. Bologna, XI. 201, t. 13 (Misc. Bot. XXI. 15, t. 3) (1861).—Rehder & Wilson in Sargent, Pl. Wilson. II. 313 (1915).—Byhouwer in Jour. Arnold Arb. XI. 88 (1929).—Léveillé, Cat. Pl. Yun-Nan, 235 (1917).

*Rosa Willmottiana* Léveillé in Fedde, Rep. Spec. Nov. XI. 299 (1912).—Willmott, Gen. Rosa, 521, t. (1914).

*Rosa Charbonneaui* Léveillé in Fedde, Rep. Spec. Nov. XIII. 338 (1914).

CHINA. Yunnan: brousse et haies a Long-ky, 700 m., E. E. Maire, June 1911, “Eglantier épineux a long rameaux; fl. blanches” (holotype of *R. Willmottiana*; photo. in A. A.); plaine de Long-tan, 2500 m., E. E. Maire, May 1913 “rosier épineux à long rameaux; fl. d'abord blanches, puis sanguines” (holotype of *R. Charbonneaui*; photo. in A. A.).

*Rosa Willmottiana* represents a form with rather large leaflets up to 8.5 cm. long and not reticulate beneath, while *R. Charbonneaui* has much smaller more finely serrate leaflets reticulate beneath.

*Rosa microcarpa* Lindley, Ros. Monog. 130, t. 18 (1820).—Rehder & Wilson in Sargent, Pl. Wilson. II. 314 (1915).

*Rosa sorbiflora* Focke in Gard. Chron. ser. 3, XXXVII. 227, fig. 96 (1905).—Léveillé, Fl. Kouy-Tchéou, 354 (1915).

*Rosa Chaffanjonii* Léveillé & Vaniot in Bull. Soc. Bot. France, LV. 56 (1908).

*Rosa Bodinieri* Léveillé & Vaniot, l. c. (1908).—Willmott, Gen. Rosa, II, 485, t. (1914).—Léveillé, Fl. Kouy-Tchéou, 353 (1914).

*Rosa Esquirolii* Léveillé & Vaniot in Bull. Soc. Bot. France, LV. 56 (1908).—Willmott, Gen. Rosa, II. 485, t. (1914).—Léveillé, Fl. Kouy-Tchéou, 353 (1915).

*Rosa Cavaleriei* Léveillé in Fedde, Rep. Spec. Nov. VIII. 61 (1910).

CHINA. Kweichou: environs de Kouy-yang, mont du Collège, haies, près des villages, *J. Chaffanjon* in herb. Bodinier, no. 2292, June 2, 1898, "tiges sans épines; fl. blanches" (holotype of *R. Chaffanjoni*; photo. and merotype in A. A.); mont de Lou-tsung-koan, cc. dans la montagne, E. Bodinier, no. 1604, May 31, 1897, "fleurs blanches" (holotype of *R. Bodinieri*; photo. and merotype in A. A.); murs de Tchen-lin, *J. Cavalerie*, no. 117, June 1904, "fl. blanches" (holotype of *R. Esquirolii*; photo. in A. A.); montagnes Hoang-tsao-pa, *J. Esquirol*, no. 1517, June 1909, "fl. blanches" (holotype of *R. Cavaleriei*; photo. and merotype in A. A.).

*Rosa Chaffanjoni* is a form with unarmed branches; the styles described as glabrous by Léveillé are villous except near the base. *R. Esquirolii* represents a form with very small leaflets.

*Rosa Banksiae* Aiton, Hort. Kew. ed. 2, III. 258 (1811).—Byhouwer in Jour. Arnold Arb. XI. 91 (1929).

*Rosa Banksiae* f. *aculeata* Léveillé, Cat. Pl. Yun-Nan, 234 (1917), nomen.

*Rosa Banksiae* f. *subinermis* Léveillé, l. c. (1917), nomen.

*Rosa Banksiae* f. *albiflora* Léveillé, l. c. (1917), nomen.

CHINA. Kweichou: Kouy-yang, mont. du Collège, dans les haies, près des villages, *J. Chaffanjon* in herb. Bodinier, no. 2259, May 15, 1898 "fl. blanches, souvent doubles"; Gan-chouen, *J. Cavalerie*, no. 3943, May 1910. Yunnan: Tong-tchouan, haies de la plaine, alt. 2500, E. E. Maire, April [1910-14], "fl. blanches doubles"; environs de Yun-nan-sen, E. Bodinier, March 24, 1897, "fl. tantôt simples, blanches, très souvent doubles."

There are no specimens in the Léveillé herbarium named f. *aculeata* and f. *subinermis*; these names were apparently taken from Focke's f. *subinermis* fl. *pleno* and f. *aculeata* fl. *pleno albo* (in Not. Bot. Gard. Edinb. v. 65, 66 [1913]). Also of f. *albiflora* there is no specimen and this name may belong either here or to the white, single-flowered *R. Banksiae* f. *normalis* Regel.

*Rosa Banksiae* f. *lutea* Lindl. Bot. Reg. XIII. t. 1105 (1827).—Byhouwer in Jour. Arnold Arb. XI. 92 (1929).

*Rosa Banksiae* f. *luteiflora* Léveillé, cat. Pl. Yun-Nan, 234 (1917), nomen.

CHINA. Yunnan: haies de la plaine à Tong-tchouan, alt. 2500 m., E. E. Maire, April [1910-14], "fl. jaunes, doubles, odorantes."

There is no specimen labeled f. *luteiflora* in Léveillé's herbarium, but the name doubtless belongs to the yellow double flowered form which is represented in his herbarium.

*Rosa lucidissima* Léveillé in Fedde, Rep. Spec. Nov. ix. 444 (1911); Fl. Kouy-Tchéou, 354 (1915).—Willmott, Gen. Rosa, II. 519, t. (1914).—Rehder & Wilson in Sargent, Pl. Wilson. II. 320 (1915), sub *R. chinensis* f. *spontanea*.

CHINA. Kweichou: Pin-fa, précipices, *J. Cavalerie*, no. 990, April 13, 1903, "fl. rouges, odorantes" (holotype; photo. in A. A.); Gan-chouen, Hin-y-fou, *J. Cavalerie*, nos. 3927, 3942, June 1912.

This peculiar Rose belongs apparently near *R. laevigata*, but differs in the less prickly and bristly branchlets and peduncles, in the adnate stipules and the red flowers; it probably is a hybrid of this species and of *R. chinensis* from which it is easily distinguished by the 3-foliate leaves and the bristly receptacle, pedicels and branchlets. Cavalerie's nos. 3927, 3942 designated by Léveillé in his herbarium as *R. lucidissima* var. lack the bristles and represent obviously a form approaching *R. chinensis*, but differing in the 3-foliate leaves with more coriaceous leaflets. *Rosa lucidissima* is very similar to  $\times$  *R. anemonoides* Rehd. (in Jour. Arnold Arb. III. 13. 1921), supposed to be a hybrid between *R. laevigata* and *R. odorata*; it differs from *R. lucidissima* chiefly in the larger pink flowers and in the stipules being adnate only about one half their length.

*Rosa odorata* Sweet, Hort. Suburb. Lond. 119 (1818).—Rehder & Wilson in Sargent, Pl. Wilson. II. 338 (1915).—Léveillé, Cat. Pl. Yun-Nan, 235 (1917)—Byhouwer in Jour. Arnold Arb. XI. 93 (1929).

*Rosa gechouitangensis* Léveillé in Fedde, Rep. Spec. Nov. XI. 299 (1912).  
*Rosa oulengensis* [sic] Léveillé, l. c. (1912).—Willmott, Gen. Rosa, II. 523, t. (1914).

*Rosa tongtchouanensis* Léveillé in Fedde, Rep. Spec. Nov. XI. 300 (1912).—Willmott, Gen. Rosa, II. 523, t. (1914).

CHINA. Yunnan: Ge-choui-tang, à flancs des coteaux calcaires, 2450 m., E. E. Maire, April 1911, "Rose thé semidouble, à long rameaux" (holotype of *R. gechouitangensis*; photo. in A. A.); Ou-long, haies des tertres, 2500 m., E. E. Maire, April 1911, "petit rosier épineux; fl. roses" (holotype of *R. oulengensis*; photo. in A. A.); haies de Tong-tchouan, alt. 2500 m., E. E. Maire, April 1911, "rosier de Bengale; fl. roses" (syntype of *R. tongtchouanensis*); haies de La-kou, alt. 2400 m., E. E. Maire, March 1911 "rosier épineux, à long rameaux; fl. blanches doubles, inodores" (syntype of *R. tongtchouanensis*; photo. in A. A.).

The three species of Léveillé's cited above are all double-flowered forms of *R. odorata* and therefore must be either cultivated or escaped from cultivation.

*Rosa odorata* var. *gigantea* (Collet) Rehder & Wilson in Sargent, Pl. Wilson. II. 338 (1915).—Léveillé, Cat. Pl. Yun-Nan, 235 (1917).—Byhouwer in Jour. Arnold Arb. XI. 94 (1929).

*Rosa Duclouxii* Léveillé in herb. ex Rehder & Wilson in Sargent, Pl. Wilson. II. 339 (1915) et ex Léveillé, Cat. Pl. Yun-Nan, 235 (1917), pro synon. *R. odorata* var. *giganteae*.

CHINA. Yunnan: environs de Yun-nan-sen, dans la mont., bord des ruisseaux, *F. Ducloux*, March 28, 1897, "grande liane sarmenteuse; gr. fl. blanches" (holotype of *R. Duclouxii*; photo. in A. A.).

*Rosa acicularis* Lindley, Monog. 44, t. 8 (1920).

*Rosa acicularis* var. *Gmelini* (Bge.) C. A. Meyer, in Mém. Acad. Sci. St. Pétersb. sér. 6, VI. 17 (Ueber Zimmros.) (1847).—Nakai in Tokyo Bot. Mag. XXX. 241 (1916); Fl. Sylv. Kor. VII. 37, t. 10 (1918). *Rosa Fauriei* Léveillé in Fedde, Rep. Spec. Nov. VII. 199 (1909), quoad Faurie, no. 99.

*Rosa Taqueti* Léveillé in Fedde, Rep. Spec. Nov. VII. 199 (1909), pro parte, quoad specimen fructibus carens.

*Rosa Korsakoviensis* Léveillé in Fedde, Rep. Spec. Nov. X. 378 (1912).—Willmott, Gen. Rosa, II. 517, t. (1914).

*Rosa acicularis* var. *Taquetii* Nakai in Tokyo Bot. Mag. XXX. 241 (1916) et Fl. Sylv. Kor. VII. 38, t. 11 (1918) pro parte, synon. citato exclud.

KOREA: secus vias regionis interioris, *U. Faurie*, no. 99, Sept. 4, 1901 (syntype of *R. Fauriei*; photo. in A. A.); Hallaisan, *E. Taquet* no. 102, Oct. 1907 (in part, as to branch without fruit; syntype of *R. Taqueti*; photo. in A. A.); in sepibus Hallaisan, 1700 m., *E. Taquet*, no. 774, Sept. 7, 1908, et Hallaisan, 1700 m., sed in horto missionis plantata, *E. Taquet*, no. 4228 May 10, 1910 (both as *R. Taqueti* in herb. Léveillé). Saghalin: circa Korsakof, *U. Faurie*, no. 570, Aug. 1908 (holotype of *R. Korsakoviensis*).

The type of *R. Fauriei* is Faurie's no. 328 which represents *R. Maximowicziana* Reg. The type of *Rosa Taqueti* is identical with *R. Wichuraiana*; the type specimen, Taquet's no. 102, consists of three branches, one with fruits on which apparently the description is based (see under *R. Wichuraiana* p. 312) and which represents *R. Wichuraiana* and two sterile specimens which belong to *R. acicularis*; the only part of the description which is clearly applicable to the two latter specimens is "caules niger et lucidus," the rest applies to *R. Wichuraiana* or both. Besides the type there are two other specimens, Taquet's no. 774 and 4228 labeled *R. Taqueti* in Léveillé's handwriting which both belong to *R. acicularis*, but are not cited with the original description. Apparently Léveillé later became confused as to the real identity of his *R. Taqueti* and applied the name to the wrong species. The same mistake was made by Nakai and therefore his name though meant for a form of *R. acicularis*, becomes technically according to the name-bringing

synonym, a synonym of *R. Wichuraiana*. The form distinguished as var. *Taquetii* by Nakai represents a form devoid of bristles.

**Rosa Marretii** Léveillé in Fedde, Rep. Spec. Nov. VIII. 281 (1910).—Willmott, Gen. Rosa, II. 495, t. (1914).—Nakai in Tokyo Bot. Mag. XXXVI. 63 (1922).

*Rosa rubrostipullata* Nakai in Tokyo Bot. Mag. XXX. 242 (1916); Fl. Sylv. Kor. VII. 40, t. 13 (1918).

SAGHALIN: circa Korsakof, *U. Faurie*, no. 571, Sept. 10, 1908 (holotype of *R. Marretii*; isotype in A. A.), no. 572, Aug. 1908 (as *R. Marretii* in herb. Léveillé; as *R. sp.* in A. A.).

*Faurie*'s no. 572 not cited with the original description is in bloom; it has like the specimen of no. 571 in the herbarium of the Arnold Arboretum slightly broader leaflets and lacks the peculiar ascending prickles at the base of the branchlets present in the type specimen. *Rosa Marretii* differs from *R. davurica* Pall. chiefly in the green, glabrous or glabrescent and not glandular under side of the leaflets and in the ascending, not recurved prickles.

**Rosa Davidi** Crép. var. *elongata* Rehder & Wilson in Sargent, Pl. Wilson. II. 323 (1915).—Byhouwer in Jour. Arnold Arb. x. 99 (1929).

*Rosa Parmentieri* Léveillé in Fedde, Rep. Spec. Nov. XIII. 339 (1914); Cat. Pl. Yun-Nan, 235 (1917).

CHINA. Yunnan: brousse de Io-chan, 3400 m., *E. E. Maire*, June 1913, "rosier épineux, buissonnant; fl. blanches" (holotype of *R. Parmentieri*; photo. in A. A.).

**Rosa sertata** Rolfe in Bot. Mag. CXXXIX. t. 8473 (1913).—Byhouwer in Jour. Arnold Arb. x. 100 (1929).

*Rosa iochanensis* Léveillé in Fedde, Rep. Spec. Nov. XIII. 339 (1914); Cat. Pl. Yun-Nan, 234 (1917).

CHINA. Yunnan: Mont Io-chan, alt. 3300 m., *E. E. Maire*, June 1913 "rosier à rameaux fins, épineux, buissonnant, haut 0.80 m.; fl. rouges" (holotype of *R. iochanensis*; photo. in A. A.).

**Rosaomeiensis** Rolfe in Bot. Mag. CXXXVIII. t. 8471 (1912).—Rehder & Wilson in Sargent, Pl. Wilson. II. 331 (1915)—Léveillé, Cat. Pl. Yun-Nan, 235 (1917).—Byhouwer in Jour. Arnold Arb. x. 102 (1929).

*Rosa Sorbus* Léveillé in Fedde, Rep. Spec. Nov. XIII. 338 (1914).

*Rosa sericea* f. *aculeata* Focke apud Léveillé, Cat. Pl. Yun-Nan, 235 (1917), nomen.

*Rosa sericea* f. *eglandulosa* Léveillé, l. c. (1917), nomen.

*Rosa sericea* f. *inermis* Léveillé, l. c. (1917), nomen.

CHINA. Yunnan: brousse à mi-mont du Io-chan, alt. 3300 m., *E. E. Maire*, June 1913, "grand rosier épineux buissonnant, 2 m.; fl. blanches," (holotype of *R. Sorbus*; photo. in A. A.).

**Rosa Mairei** Léveillé in Fedde, Rep. Spec. Nov. xi. 299 (1912); Cat. Pl. Yun-Nan, 235 (1917).—Willmott, Gen. Rosa, II. 521 (1914).—Rehder & Wilson in Sargent, Pl. Wilson. II. 343 (1915).—Byhouwer in Jour. Arnold Arb. x. 103 (1929).

CHINA. Yunnan: collines arides autour de Tong-chouan, 2600 m., *E. E. Maire*, April 1911, "rosier buissonnant, à fortes épines triangulaires; fl. blanches" (holotype; photo. in A. A.).

**Prunus Persica** (L.) Batsch, Beytr. Entwick. Gesch. Naturr. 30 (1801).—Léveillé in Mem. Acad. Ci. Art. Barcelona, ser. 3, XII. 560 (Cat. Pl. Kiang-Sou, 20) (1916).

*Prunus Persica* var. *lasiocalyx* Léveillé & Vaniot in Bull. Bot. Soc. France, LV. 58 (1908); in Mem. Acad. Ci. Art. Barcelona, ser. 3, XII. 560 (Cat. Pl. Kiang-Sou, 20) (1916).

*Prunus daemonifuga* Léveillé & Vaniot in Bull. Bot. Soc. France, LV. 58 (1908).

CHINA. Kiangsu: Song-kiang-fan, *Ch. d'Argy* (5 specimens, syntypes of *P. Persica* var. *lasiocalyx*; photo. in A. A.); Tao-chow; Tao-tze-chow, *Ch. d'Argy* (holotype of *P. daemonifuga*; photo. in A. A.).

*Prunus persica* var. *lasiocalyx* seems scarcely different from the type and *P. daemonifuga* was reduced to synonymy by Léveillé himself in 1916 (l. c.).

**Prunus Persica** var. *longistyla* Léveillé in Bull. Bot. Soc. France, LV. 58 (1908); in Mem. Acad. Ci. Art. Barcelona, ser. 3, 560 (Cat. Pl. Kiang-Sou, 20) (1916).

CHINA. Kiangsu: without locality, *Ch. d'Argy*? (holotype; photo. in A. A.).

On account of its long style this variety resembles *P. kansuensis* Rehd. which differs, however, in its slenderer branches, glabrous winter-buds, less pubescent sepals glabrous inside, white or nearly white, rather smaller flowers and is only known as a wild plant from the Kansu-Tibetan frontier at altitudes of 6000–8000 ft.; it also differs markedly from *P. Persica* in its stone not being pitted. Léveillé's variety is apparently a form of the cultivated Peach, though the length of the style is an unusual character in this species.

**Prunus japonica** var. *Nakaii* (Lévl.) Rehder in Jour. Arnold Arb. III. 29 (1921).

*Prunus Nakaii* Léveillé in Fedde, Rep. Spec. Nov. VII. 198 (1909), "P. Nakai".—Koehne in Sargent, Pl. Wilson. I. 267 (1912).—Nakai, Fl. Sylv. Kor. v. 36, t. 22 (1916).

KOREA: Ouen-san, in lacunis montium, *U. Faurie*, no. 334, July 1906 (holotype of *P. Nakai*; isotype in A. A.).

**Prunus discadenia** Koehne in Sargent, Pl. Wilson. I. 200 (1912).

*Prunus myrtacea* Léveillé in Bull. Géog. Bot. xxv. 45 (1915); Cat. Pl. Yun-Nan, 234 (1917).

CHINA. Yunnan: brousse des montagnes à Pe-long-tsin, 3200 m., *E. E. Maire*, June 1912 (holotype of *P. myrtacea*; photo. in A. A.).

*Prunus odontocalyx* Léveillé in Bull. Géog. Bot. xxv. 45 (1915); Cat. Pl. Yun-Nan, 234 (1917).

CHINA. Yunnan: haut plateau de Ta-hai-tse, 3200 m., *E. E. Maire*, May 1912 (holotype; merotype in A. A.).

This species I have not been able to identify with any previously described *Prunus*. It apparently belongs in Koehne's Series Oxyodonta of his subsection Ceraseidos, but differs from the species known to me in its longer and narrower leaves (not yet fully unfolded) quite glabrous except a fugaceous silky pubescence along the midrib and in the 2-3-flowered racemes on a short peduncle 3-5 mm. long with narrow oblong-lanceolate caducous bracts to 1 cm. long.

*Prunus Padus* Linnaeus, Spec. Pl. 473 (1753).—Nakai, Fl. Sylv. Kor. v. 18, t. 3 (1916).

*Prunus Fauriei* Léveillé in Fedde, Rep. Spec. Nov. vii. 198 (1909).

KOREA. Quelpaert: Hallaisan, 1500 m., *U. Faurie*, no. 1549, June 17, 1907, "rara, e basi ramosa, 2 m., alta 5-6 m. lata" (holotype of *P. Fauriei*; photo. in A. A.).

Nakai (op. cit. 15) cites *P. Fauriei* as a synonym under *P. Buergeri* Miq. (= *P. Buergeriana* Miq.), but under *P. Padus* he cites "*P. Fauriei* Lévl. in litt. fide Taquet." Koehne (in Fedde, Rep. Spec. Nov. xii. 135. 1913) states that *P. Fauriei* hardly differs from *P. Padus*, to which I agree with the original specimen from the Herbarium Léveillé before me.

*Prunus Padus* L. var. *seoulensis* (Lévl.) Nakai, Fl. Sylv. Kor. v. 19 (1916).

*Prunus seoulensis* Léveillé in Fedde, Rep. Spec. Nov. vii. 198 (1909).

KOREA: Namsan Seoul, *U. Faurie*, no. 331, July 1906 (holotype of *P. seoulensis*; isotype in A. A.).

Koehne (in Fedde, Rep. Spec. Nov. xii. 134. 1913) states that *P. seoulensis* hardly differs from typical *P. Padus* and that it possibly belongs to var. *commutata* Dipp.

*Prunus pubigera* (Schneid.) Koehne in Sargent, Pl. Wilson. 1. 67 (1911).

*Prunus (Padus) Vanioti* Léveillé in Bull. Géog. Bot. xxv. 45 (1915); Cat. Pl. Yun-Nan, 234 (1917).

CHINA. Yunnan: flanc aride des montagnes à Ma-kong, 2700 m., *E. E. Maire*, April 1912 (holotype of *P. Vanioti*; merotype in A. A.).

**Prunus Maackii** Rupr. var. *diamantina* (Lévl.) Koehne in Fedde, Rep. Spec. Nov. XII. 134 (1913).

*Prunus diamantina* Léveillé in Fedde, Rep. Spec. Nov. VII. 198 (1909).

CHINA: in Monte des Diamants, *U. Faurie*, no. 332 (holotype of *P. diamantina*).

Nakai (Fl. Sylv. Kor. v. 17. 1916) refers *P. diamantina* to *P. Maackii* as a synonym without recognizing it as a variety.

#### LEGUMINOSAE

**Albizzia kalkora** (Roxb.) Prain in Jour. As. Soc. Bengal, LXVI. 511 (1897).

*Albizzia Esquirolii* Léveillé, Fl. Kouy-Tchéou, 224 (1914).—Synon. nov.

CHINA. Kweichou: Tou-chan, *J. Cavalerie* in herb. Bodinier, no. 2634, June 1899 (ex Léveillé; syntype of *A. Esquirolii*); same locality, *J. Esquirol*, no. 431, June 1905 (syntype of *A. Esquirolii*; merotype in A. A.).

**Acacia Delavayi** Franchet, Pl. Delavay. 194 (1890).

*Acacia Cavaleriei* Léveillé, Fl. Kouy-Tchéou, 222 (1914), nomen.—Synon. nov.

CHINA. Kweichou: Mou-you-se, *J. Cavalerie*, no. 2041, June 1904 "tige lianeuse court sur les murs" (holotype of *A. Cavaleriei*; photo. in A. A.).

I have not seen the type of *A. Delavayi*, but Cavalerie's specimen which is in bloom seems to agree well with Delavay's description except that the only leaf present has 6 pairs of pinnae and the leaflets are up to 1 cm. long; Franchet describes also the fruit, but Cavalerie's specimen has only flower-heads mostly in bud.

The original description of *Acacia Cavaleriei* I have not been able to locate; possibly Léveillé did not publish a description.

**Bauhinia touranensis** Gagnepain in Lecomte, Not. Syst. II. 181 (March 25, 1912); in Lecomte, Fl. Gén. Indo-Chine, II. 134, fig. 14, 8-18 (1913).—Léveillé, Fl. Kouy-Tchéou, 227 (1914).

*Bauhinia Rocheri* Léveillé in Fedde, Rep. Spec. Nov. XI. 31 (July 1, 1912).

CHINA. Kweichou: forêt de Siang-chou, alt. 800 m., *J. Esquirol*, no. 2131, May 20, 1910 (holotype of *B. Rocheri*; photo. in A. A.); Houkiang, *J. Cavalerie*, no. 2128, June 1904 (ex Léveillé, Fl. Kouy-Tchéou).

*Bauhinia Rocheri* was referred to *B. touranensis* as a synonym by Gagnepain in 1913 (l. c.).

**Bauhinia densiflora** Franchet, Pl. Delavay. 191 (1890).—Léveillé, Fl. Kouy-Tchéou, 227 (1914).

*Bauhinia Cavaleriei* Léveillé in Fedde, Rep. Spec. Nov. XI. 31 (1912).

CHINA. Kweichou: Lo-fou, *J. Cavalerie*, no. 3676, Aug. and Oct. 1908, 1909 (holotype; photo. in A. A.); Pin-fa, *J. Cavalerie*

no. 659; descente du fleuve, *J. Esquirol*, nos. 507, 890 (ex Léveillé, Fl. Kouy-Tchéou).

*Bauhinia Cavaleriei* was referred by Léveillé as a synonym to *B. densiflora* in his Flore du Kouy-Tchéou.

***Bauhinia yunnanensis* Franchet, Pl. Delavay. 190 (1890).**

*Bauhinia altefissa* Léveillé, Fl. Kouy-Tchéou, 226 (1914); Cat. Pl. Yun-Nan, 152 (1916).—*Synon. nov.*

**CHINA.** Kweichou: Mou-you-se, *J. Cavalerie*, no. 3908, June 1912 (syntype of *B. altefissa*; photo. in A. A.); without locality, *J. Esquirol*, no. 511 (syntype of *B. altefissa*; photo. in A. A.).

*Bauhinia altefissa* agrees perfectly with *B. yunnanensis*, but Esquirol's no. 3056 "derrière le camp de Lo-hou, Juillet 1911" cited by Léveillé under the original description of *B. altefissa* does not belong here; the specimen is sterile and probably belongs to *B. densiflora* Franch.

***Bauhinia aurea* Léveillé in Bull. Soc. Bot. France, LIV. 368 (1907); Fl. Kouy-Tchéou, 226 (1914).**

**CHINA.** Kweichou: rochers et bois des environs de Lo-fou, *J. Cavalerie*, no. 2614, Nov. 1905 (holotype; photo. in A. A.); Pin-fa, *J. Cavalerie*, no. 2614; Lao-ten, *E. Bodinier*, no. 43; Ou-la-gay, *J. Seguin*; confluent des deux rivières de Lo-kouy; *J. Esquirol*, no. 3226, 1898-1912. (All enumerated by Léveillé, Fl. Kouy-Tchéou.)

This species resembles in the size, tomentum and general outline of the leaf *B. Vahlii* Wight et Arn., but differs in the somewhat acutish not rounded lobes, and in the narrow, not open, basal sinus; also the pod which I have not seen agrees according to the description with that of *B. Vahlii*. I have not seen the additional specimens cited in the Flore du Kouy-Tchéou. A similar form also only in fruit has been collected in Kweichou by Y. Tsiang (no. 7289) near Gan-wu, Lo-hu on the Kwangsi border, but the leaves are subcordate to nearly truncate at base, while the lobes are acutish.

***Pterolobium punctatum* Hemsley in Jour. Linn. Soc. XXIII. 207 (1887).**

*Prosopis Esquirolii* Léveillé, Fl. Kouy-Tchéou, 242 (1914).—*Synon. nov.*

**CHINA.** Kweichou: de Tong-fong-tcheou à Sy-pou-ho, *J. Esquirol*, no. 166, Aug. 1904 (holotype of *Prosopis Esquirolii*; merotype in A. A.).

***Sophora japonica* Linnaeus, Mant. I. 68 (1767).—Léveillé, Fl. Kouy-Tchéou, 243 (1914); Cat. Pl. Yun-Nan, 161 (1916).**

*Ormosia Esquirolii* Léveillé, Fl. Kouy-Tchéou, 240 (1914).—*Synon. nov.*

*Sophora Mairei* Léveillé in Bull. Géog. Bot. XXV. 48 (1915); non *S. Mairei* Pamp. (1910).—*Synon. nov.*

CHINA. Kweichou: Lao-ouang-tchai, *J. Esquirol*, no. 3840, July 1912, "arbre 6 m.; fl. blanches" (holotype of *Ormosia Esquirolii*; merotype in A. A.). Yunnan: plaine de Tong-tchouan, alt. 2500 m., *E. E. Maire*, Aug. [1911-14], "gros et grand arbre; fleurs blanches inodores" (holotype of *S. Mairei*; merotype in A. A.).

*Sophora glauca* De Candolle in *Ann. Sci. Nat. ser. 1, iv. (1824) 98 (1825)*.—Gagnepain in Lecomte, *Not. Syst. III. 117 (1915)*.—Léveillé, *Cat. Pl. Yun-Nan, 161 (1916)*.

*Indigofera Mairei* Léveillé in Fedde, *Rep. Spec. Nov. XII. 190 (1913)*.

CHINA. Yunnan: coteaux calcaires arides, derrière La-kou, 2450 m., *E. E. Maire*, June 1911, "fleurs violettes" (syntype of *Indigofera Mairei*; photo. in A. A.); plaine de Kiao-kia, alt. 400 m., *E. E. Maire*, July 1911, "fleurs violettes" (syntype of *Indigofera Mairei*; photo. in A. A.).

*Indigofera Mairei* has been identified already by Gagnepain (l. c.) with *Sophora glauca*.

*Sophora glauca* var. *albescens* Rehder in Sargent, *Pl. Wilson. III. 447 (1917)*.

*Sophora Cavaleriei* Léveillé, *Fl. Kouy-Tchéou, 242 (1914)*.—Synon. nov.

CHINA. Kweichou: Hin-y-fou, *J. Cavalerie*, no. 3909, June 1912 (holotype of *S. Cavaleriei*; photo. in A. A.).

Cavalerie's no. 3909 is somewhat less pubescent than *S. glauca* usually is. Var. *albescens* is apparently a mere color-form; the differences in the shape of the leaflets given in the original description do not seem to hold. Both forms, with violet and with yellowish white flowers, occur in Szechuan as well as in Yunnan.

*Maackia Fauriei* (Lévl.) Takeda in *Not. Bot. Gard. Edinb. VIII. 101, t. 27, fig. 39-43 (1913)*.

*Cladrastis Fauriei* Léveillé in Fedde, *Rep. Spec. Nov. VII. 230 (1909)*.

KOREA. Quelpaert: Hallaisan, 1200 m., *U. Faurie*, no. 1692, Aug. 1907 (holotype of *C. Fauriei*; isotype in A. A.).

*Indigofera stachyodes* Lindley in *Bot. Reg. I. t. 14 (1843)*.

*Indigofera Bodinieri* Léveillé in Fedde, *Rep. Spec. Nov. XII. 190 (1913)*.—Gagnepain in Lecomte, *Not. Syst. III. 117 (1915)*, pro synon. *Indigoferae dosua* Buch.-Ham.

*Indigofera Dosua* Buch.-Ham. var. *stachyodes* (Lindl.) Léveillé, *Fl. Kouy-Tchéou, 234 (1914)*.

CHINA. Kweichou: dans la montagne aux environs de Ganpin, *Leon Martin* et *E. Bodinier*, no. 1822, Sept. 24, 1897 (syntype of *I. Bodinieri*; photo. in A. A.); Tsin-gay à Tong-mou-lin, *E. Bodinier*, no. 1822 bis, June 24, 1899 (syntype of *I. Bodinieri*; photo. in A. A.).

*Indigofera Dosua* Buch.-Ham. listed by Léveillé in his *Cat. Pl. Yun-Nan (p. 156)* probably also refers to *I. stachyodes* Lindl. (*I.*

*Dosua* var. *tomentosa* Bak.) and not to typical *I. dosua* Buch.-Ham., of which I have seen no specimens from Yunnan.

**Indigofera Esquirolii** Léveillé in Fedde, Rep. Spec. Nov. xii. 190 (1913); Fl. Kouy-Tchéou 234 (1914).—Gagnepain in Lecomte, Not. Syst. III. 117 (1915).

CHINA. Kweichou: Ouang-mou, *J. Esquirol*, no. 48, May 25, 1904 (holotype; photo. in A. A.); Tou-chan; Tsin-gay, bord de la rivière de Cha-téou-tche, *J. Cavalerie* in Herb. Bodinier, no. 2374, Nov. 1898 (cited in Fl. Kouy-Tchéou, l. c.).

This species seems nearest to *I. Dielsiana* Craib, but differs in its densely pubescent larger leaflets up to 3 cm. long, in the larger racemes up to 12 cm. long and shorter calyx-tube with longer lobes. Gagnepain (l. c.) also states that it seems to be a new species.

**Indigofera Vanioti** Léveillé, Cat. Pl. Yun-Nan, 157 (1916), excl. specim. e Lou-pou.

Fruticulus ramosus, 40 cm. altus; ramuli ut pedunculus et rhachis racemi pilis mediofixis albidis et sparsius glandulis fulvis conspersi. Folia 7-9-foliolata, cum petiolo 5-8 mm. longo ut rhachis sparse pilis mediofixis et glandulis paucis instructo ad 3 cm. longa; stipulae 2 mm. longae; foliola opposita, oblonga vel obovato-oblonga, 6-9 mm. longa et 2-3.5 mm. lata, vel interdum in folius minoribus ovalia vel obovata, apice rotundata et mucronulata, basi rotundata vel late cuneata, supra glabra vel interdum pilis mediofixis paucis instructa et intense viridia, subtus pallida et pilis mediofixis conspersa, nervis obsoletis, petiolulo ad 1 mm. longo suffulta; stipellae saepe petiolulum fere aequantes. Racemi ad 5 vel 6 cm. longi, pedunculo 5-10 mm. longo suffulti; bracteae deciduae at 2 mm. longae; pedicelli 1 mm. longi ut calyx pilis mediofixis obtecti; flores violacei; calycis tubus circiter 1 mm., lobus infimus subulatus 1.75 mm. longus; vexillum 6-7 mm. longum et 3.5-4 mm. latum, apice rotundatum, minute mucronulatum, extus dense pubescens; alae 6 mm. longae et 1.5 latae, superne ciliolatae, carina 6.5 mm. longa superne extus pubescens, auriculis quam unguiculi multo brevioribus; ovarium glabrum.

CHINA. Yunnan: pâtures du mont Tsouan-tien-po, alt. 2700 m., E. E. Maire, May [1911-12] "fl. violettes" (syntype of *I. Vanioti*: merotype in A. A.).

Léveillé enumerates under his *I. Vanioti* two specimens. He compares his new species with *I. Hosiei* and *I. lenticellata* and states that it differs "a primo stipellis conspicuis; a secundo lenticellis nullis. Flores violacei, 0.40 cm. alta." This is all the description he gives. The two specimens Léveillé cites are not identical, and

only one, the specimen cited above, has stipels which could be called conspicuous, the other specimen from Lou-pou has no noticeable stipels and I consider it identical with *I. szechuensis* Craib. I therefore take the specimen from Tsouan-tien-po as the type of Léveillé's species, though the label is without name, and have given above a description of *I. Vanioti* based on this specimen. It differs from *I. szechuensis* and from *I. Hosiei* and *I. lenticellata* at the first glance by the leaflets being glabrous or nearly so above. It seems nearest related to *I. Silvestrii* Pamp. which is readily distinguished according to the description by the smaller flowers with the wings exceeding the standard and the white-pubescent ovary; I have seen no specimen of *I. Silvestrii*.

**Indigofera szechuensis** Craib in Notes Bot. Gard. Edinb. VIII. 62 (1913).

*Indigofera Vanioti* Léveillé, Cat. Pl. Yun-Nan, 157 (1916), quoad specimen Lou-pou.

CHINA. Yunnan: vallée de Lou-pou, alt. 3000 m., E. E. Maire, June [1911-12] "fl. violettes" (syntype of *I. Vanioti*; merotype in A. A.).

This specimen agrees well with the type of *I. szechuensis* except that the leaflets are somewhat narrower and number only 7-9. It bears the name *I. Vanioti* in Léveillé's handwriting on the label, while the specimen which I consider the type of *I. Vanioti* has no name on its label, but both specimens were placed in the cover of *I. Vanioti* in Léveillé's herbarium.

**Indigofera reticulata** Franchet, Pl. Delavay. 153 (1889).

*Indigofera Craibiana* Léveillé, Cat. Pl. Yun-Nan, 155 (1916).—Synon. nov.

CHINA. Yunnan: monticule calcaire de Kin-tchong-chan, alt. 2550 m., E. E. Maire, Aug. [1911-12] (syntype of *I. Craibiana*; merotype in A. A.); pâturages de montagnes à Tong-tchouan, alt. 2600 m., E. E. Maire (ex Léveillé; syntype of *I. Craibiana*).

**Indigofera atropurpurea** Buchanan-Hamilton apud Roxburgh, Hort. Bengal. 57 (1814), nomen; Fl. Ind. III. 381 (1832).—Léveillé, Fl. Kouy-Tchéou, 234 (1914).

*Indigofera Cavaleriei* Léveillé in Fedde, Rep. Spec. Nov. XII. 190 (1913).—Gagnepain in Lecomte, Not. Syst. III. 117 (1914), pro synon. *I. atropurpurea*.

CHINA. Kweichou: Tsin-gai, bord du ruisseau, *J. Cavalerie*, no. 1191, July 1903 (holotype; photo. in A. A.).

*Indigofera Cavaleriei* was identified with *I. atropurpurea* in 1914 by Gagnepain (l. c.) and in the same year enumerated by Léveillé in his Flore du Kouy-Tchéou (l. c.) as *I. atropurpurea*, but without citation of *I. Cavaleriei* as a synonym, though its type, Cavalerie no. 1191, is cited with the addition of Cavalerie no. 2672.

**Millettia Dielsiana** Harms in Bot. Jahrb. xxix. 412 (1900).

*Millettia Blinii* Léveillé, Fl. Kouy-Tchéou, 238 (1914).—*Synon. nov.*

*Millettia Bodinieri* Léveillé, l. c.—*Synon. nov.*

*Millettia Dunniana* Léveillé, Cat. Pl. Yun-Nan, 159 (1916).—*Synon. nov.*

*Millettia fragrantissima* Léveillé, Fl. Kouy-Tchéou, 239 (1914).—*Synon. nov.*

**CHINA.** Kweichou: Tang-tchang, *J. Esquirol*, no. 1568, June 1909 (holotype of *M. Blinii*; photo. in A. A.); Gan-pin, Kouy-yang, L. Martin in herb. E. Bodinier, no. 2391, June 1896 and 1897, “branches en liane, trainant sur les rochers, fleurs pourpres (Gaytéou)” (holotype of *M. Bodinieri*; photo. in A. A.); Tsin-gai, *J. Cavalerie*, no. 1133, July 14, 1903, “fl. rouge-rose à l'ext., sens delicieus” (holotype of *M. fragrantissima*; photo. in A. A.). Yunnan: brousse, rives des fleuve Bleu, alt. 400 m., E. E. Maire, July 1912, “fleurs roses” (holotype of *M. Dunnii*; photo. in A. A.).

The specimens cited above which are all flowering belong apparently to the variable *M. Dielsiana* which varies in the shape and in the pubescence of the leaves; in *M. fragrantissima* and *M. Blinii* the leaves are glabrous beneath, in *M. Bodinieri* and *M. Dunniana* pubescent.

**Millettia Gentiliana** Léveillé, Fl. Kouy-Tchéou, 239 (1914).

**CHINA.** Kweichou: Pin-fa, descente de Kouan-lin, *J. Cavalerie*, no. 644, June 10, 1904 (holotype; merotype in A. A.).

This species seems near *M. cinerea* Benth., but as the latter species has not yet been recorded from Kweichou, I hesitate to identify *M. Gentiliana*, which is only represented by a fruiting specimen, definitively with *M. cinerea*.<sup>1</sup>

**Caragana Franchetiana** Komarov in Act. Hort. Bot. Petrop. xxix. 300, t. 13A (1908).

*Caragana Komarovii* Léveillé, in Bull. Géog. Bot. xxv. 49 (1915).—*Synon. nov.*

**CHINA.** Yunnan: rochers des montagnes de Lou-pou et Tongtchouan, alt. 2800–3200 m., E. E. Maire, July 1912, “arbuste épineux buissonnant, fleurs papil. jaunes” (holotype of *C. Komarovii*; merotype in A. A.).

*Caragana Komarovii* is an extreme form of the variable *C. Franchetiana* with strong spines up to 6 mm. long and with less pubescent and more numerous leaflets (up to 9 pairs).

**Desmodium racemosum** (Thunb.) De Candolle, Prodr. II. 337 (1825).—Schindler in Fedde, Rep. Spec. Nov. Beih. XLIX. 227 (Desmodiinae) (1928).

*Desmodium Bodinieri* Léveillé, Fl. Kouy-Tchéou, 232 (1914).

<sup>1</sup> *Millettia Esquirolii* Léveillé, Fl. Kouy-Tchéou, 239 (1914) is not a *Millettia*, from which it differs in its alternate estipellate leaflets and racemose flowers; it may belong to *Pongamia* or *Derris*, but in the absence of fruits its position remains doubtful.

CHINA. K w e i c h o u: Kouy-yang; mont. du Collège; Gan-pin; *E. Bodinier*, no. 1753 (ex Léveillé; syntypes; photo. in A. A.).

Of *D. Bodinieri* there is at present but one specimen in the Herbarium Léveillé, without collector or locality, only with a label bearing the name "*D. Bodinieri Lévl.*" in Léveillé's handwriting. In a note appended to the genus in the Flore du Kouy-Tchéou Léveillé states that the localities given under the species of this genus are incomplete or lacking, since the specimens were at that time in the hands of Dr. Diels. The fruit of Bodinier's specimen is pubescent, not glabrous as described by Thunberg and De Candolle.

**Desmodium cinerascens** Franchet, Pl. Delavay. 174 (1890).

*Desmodium Esquirolii* Léveillé, Fl. Kouy-Tchéou, 232 (1914); Cat. Pl. Yun-Nan, 154 (1916).—**Synon. nov.**

CHINA. K w e i c h o u: without locality, *J. Cavalerie*, no. 3274 (ex Léveillé; holotype of *D. Esquirolii*); without locality, *J. Cavalerie*, no. 3998 (in herb. Léveillé under *D. Esquirolii*). Y u n n a n: mont. de Ta-choui-tsín, alt. 2300 m., *E. E. Maire*, June [1911-12], "arbuste, feuil. caduques, fl. violettes" (in herb. Léveillé under *D. Esquirolii*).

On the sheet of Maire's Yunnan specimen there are two specimens of which that with less pubescent leaves may not belong to *D. cinerascens*. *Desmodium cinerascens* seems to vary greatly in the amount of pubescence; all the specimens in this herbarium referred by Schindler to *D. cinerascens* are much more pubescent than Franchet's type.

**Desmodium gyroides** (Roxb.) De Candolle, Prodr. II. 326 (1825).

*Desmodium oxalidifolium* Léveillé, Fl. Kouy-Tchéou, 233 (1914), pro parte.—**Synon. nov.**

CHINA. K w e i c h o u: Lo-fou, coteaux, alt. 600 m., *J. Esquirol*, no. 2205, Sept. 1910, "couleur violette" (syntype of *D. oxalidifolium*, in part; photo. in A. A.).

The other specimen cited by Léveillé under *D. oxalidifolium* belongs to the following species.

**Desmodium Griffithianum** Bentham in Junghuhn, Pl. Junghuhn. 222 (1852).—Schindler in Fedde, Rep. Spec. Nov. Beih. XLIX. 227 (Desmodiinae) (1928).

*Desmodium oxalidifolium* Léveillé, Fl. Kouy-Tchéou, 233 (1914), pro parte.

CHINA. K w e i c h o u: Tong-kia-tchao; Tsin-tchen, *E. Bodinier*, no. 1731 (ex Léveillé; syntype of *D. oxalidifolium*); without locality, "no. 42" (in Herb. Léveillé sub *D. oxalidifolium*; photo. in A. A.).

Bodinier's no. 1731 is not now in the Herb. Léveillé but there is a specimen without locality and collector, labeled *D. oxalidifolium* in

Léveillé's handwriting, which agrees with Léveillé's description, while the other syntype cited under the preceding species does not fit the description.

*Desmodium concinnum* De Candolle, Prodr. II. 335 (1825).

*Desmodium barbigerum* Léveillé, Pl. Cat. Yun-Nan, 153 (1916).—*Synon. nov.*

CHINA. Yunnan: pâtures des coteaux arides à Ou-long-mo, alt. 2550, *E. E. Maire*, July [1911-12] "vivace en touffes, mi-rampante, fl. violettes" (syntype of *D. barbigerum*); pâtures des coteaux à Ma-gan-chan, alt. 2550 m., *E. E. Maire*, Aug. (1911-12), "vivace, couchée" (syntype of *D. barbigerum*; photo. in A. A.).

Maire's specimens differ from the material of *D. concinnum* before me in the darker colored flowers with purple calyx. The plant also seems to differ in its habit; Maire describes it as a procumbent or nearly creeping perennial, while according to the description of the Himalayan plant it is a tall shrub with pendulous branches.

*Desmodium gangeticum* (L.) De Candolle, Prodr. II. 327 (1825).—Schindler in Fedde, Rep. Spec. Nov. Beih. XLIX. 227 (Desmodiinae) (1928).

*Desmodium Cavaleriei* Léveillé, Fl. Kouy-Tchéou, 232 (1914).

CHINA. Kwei-chou: without locality, *J. Cavalerie*, no. 3274, (holotype; photo. in A. A.).

*Lespedeza Forrestii* Schindler in Notes Bot. Gard. Edinb. VIII. 13, t. 8 (1913).

*Lespedeza Pampaninii* Léveillé in Bull. Géog. Bot. XXV. 48 (1915); Fl. Kouy-Tchéou, 158 (1916).—*Synon. nov.*

CHINA. Yunnan: pâtures de Io-chan, alt. 3200 m., *E. E. Maire*, June 1912, "polygonum vivace rampant, fleurs rouges" (holotype of *L. Pampaninii*; merotype in A. A.)

*Lespedeza Monnoyeri* Léveillé, Cat. Pl. Yun-Nan, 158 (1916).

CHINA. Yunnan: terrains arides, collines derrière La-kou, alt. 2400 m., *E. E. Maire*, July 1912, "legum. vivace rampant, fleurs roses" (holotype; merotype in A. A.).

Very distinct with its broadly ovate or almost obovate leaflets and the rather long-peduncled flowers.

*Lespedeza daurica* (Laxm.) Schindler in Fedde, Rep. Spec. Nov. XXII. 274 (1926).

*Lespedeza trichocarpa* Persoon, Syn. Pl. II. 318 (1807).—Schindler in Bot. Jahrb. XLIX. 607 (1913).

*Lespedeza Fauriei* Léveillé in Fedde, Rep. Spec. Nov. VII. 230 (1909).

KOREA: in herbidis Chinnampo, *U. Faurie*, no. 415, Aug. 1906 (holotype of *L. Fauriei*; photo. and isotype in A. A.).

According to notes on the sheet of the type specimen of *L. Fauriei* it was identified as *L. trichocarpa* in 1910 by Pampanini and in 1912 by Schindler; the isotype in this herbarium also was identified in 1912 by Schindler as *L. trichocarpa* and the identification published in 1913 (l. c.).

*Lespedeza striata* (Thunb.) Hooker & Arnott, Bot. Voy. Beechey, 262 (1841).—Léveillé, Cat. Pl. Yun-Nan, 159 (1916).

*Trifolium ? polygonum* Léveillé in Fedde, Rep. Spec. Nov. xii. 282 (1913).

CHINA. Yunnan: plaine et montagne a Tche-hai, alt. 2500–2600 m., E. E. Maire, July 1912 (holotype of *Trifolium polygonum*; photo. in A. A.).

*Trifolium polygonum* was referred to *Lespedeza striata* by Léveillé in 1916 (l. c.).

*Campylotropis polyantha* (Franch.) Schindler in Fedde, Rep. Spec. Nov. xi. 340 (1912).

*Lespedeza Blinii* Léveillé in Bull. Bot. Géog. xxv. 48 (1915); Cat. Pl. Yun-Nan, 157 (1916).—*Synon. nov.*

*Lespedeza dichromocalyx* Léveillé, Fl. Kouy-Tchéou, 236 (1914); Cat. Pl. Yun-Nan, 157 (1916).—*Synon. nov.*

CHINA. Kweichou: monts entre Hin-y-hien et Hin-y-fou, E. Bodinier, no. 2279, April 12, 1897 (syntype of *Lespedeza dichromocalyx*; merotype in A. A.); Gan-chouen, *J. Cavalerie*, no. 3997, Aug. 28, 1912 (syntype of *L. dichromocalyx*; merotype in A. A.). Yunnan: environs de Yunnan-sen, bords de canaux, des routes, E. Bodinier, March 11, 1897 (syntype of *L. dichromocalyx*; merotype in A. A.); commun sur les rives rocheuses du fleuve Bleu à Mong-kou, alt. 500 m., E. E. Maire, April (1911–14) (holotype of *Lespedeza Blinii*; photo. in A. A.).

*Campylotropis velutina* (Dunn) Schindler in Fedde, Rep. Spec. Nov. xx. 286 (1924).

*Millettia Cavaleriei* Léveillé, Fl. Kouy-Tchéou, 238 (1914).—*Synon. nov.*

CHINA. Kweichou: Lo-kouen, ouest de Lo-fou, *J. Cavalerie*, no. 2754, Apr. 1906, “fl. blanches” (holotype of *Millettia Cavaleriei*; photo. in A. A.); Lo-fou, *J. Cavalerie*, no. 3683, Apr. 1909, “fl. blanches violacées” and *J. Cavalerie*, no. 1406 (both in cover of *M. Cavaleriei* in herb. Léveillé; duplicates in A. A.).

*Dalbergia Esquirolii* Léveillé, Fl. Kouy-Tchéou, 230 (1914).

CHINA. Kweichou: Hoang-tsao-po, colline de la pagode, *J. Esquirol*, no. 1351, June 5, 1909 (holotype; photo. in A. A.).

This species seems near *D. Dyeriana* Prain, but differs in the narrow-oblong leaflets 1.5–3 cm. long and 6–9 mm. broad, and narrowed toward the obtuse apex, in the terminal inflorescence and in the calyx being nearly glabrous except the ciliate lobes.

**Dalbergia Cavaleriei** Léveillé, Fl. Kouy-Tchéou, 230 (1914).

CHINA. Kweichou: Hoa-kiang et descente du même fleuve, *J. Cavalerie*, no. 3918, June 1912 (syntype; photo. in A. A.).

Similar to *D. mimosoides* Franch. and *D. stenophylla* Prain, but easily distinguished by the leaflets being appressed-pubescent on both sides. The same species has been collected in Kweichou also by Handel-Mazzetti (no. 10352).

**Derris** spec. Léveillé, Fl. Kouy-Tchéou, 231 (1914).

*Indigofera Thirionni* Léveillé in Fedde, Rep. Spec. Nov. xii. 190 (1913).—Gagnepain in Lecomte, Not. Syst. III. 117 (1915), pro synon. *Derris* vel *Millettiae* spec.

CHINA. Kweichou: Ouang-mou, *J. Esquirol*, no. 117, June 1904, "petit arbrisseau, fl. rose" (holotype of *I. Thirionni*; photo. in A. A.).

The specimen consists of flowering branches with all the leaflets and most of the flowers fallen off and some young leaflets and flowers in a pocket and is too meagre for exact determination. Gagnepain in a note on the type specimen refers it doubtfully to *Derris* or perhaps *Millettia*; according to its inflorescence and flowers it seems to be a *Derris*.

**Dumasia villosa** De Candolle, Mém. Fam. Legum. 257, t. 44 (1825); Prodr. II. 241 (1825).

*Erythrina Mairei* Léveillé in Bull. Géog. Bot. xxv. 50 (1915); Cat. Pl. Yun-Nan, 155 (1916).—*Synon. nov.*

*Apis Mairei* Lévl. in herb. Léveillé, l. c. (1915), pro synon.

CHINA. Yunnan: sous bois de Pan-lang-se, alt. 2500 m., *E. E. Maire*, Sept. (1912) "plante grimpante vivace, fl. jaune d'or" (holotype; photo. in A. A.).

**Mucuna terrens** Léveillé in Fedde, Rep. Spec. Nov. XIII. 264 (May 5, 1914).

*Mucuna corvina* Gagnepain in Lecomte, Not. Syst. III. 28 (May 24, 1914).—Léveillé, Fl. Kouy-Tchéou, 240 (1914).

CHINA. Southern Kweichou: without precise locality, *J. Cavalerie*, no. 2974, April 1908 "grande liane à fleur noire" (ex Léveillé; holotype of *M. terrens*); Gan-chouen, *J. Cavalerie*, nos. 3782, 3785?, May and Dec. 1910 (ex Gagnepain; syntypes of *M. corvina*).

In his Flore du Kouy-Tchéou Léveillé cites his *M. terrens* as a synonym of *M. corvina*, though it has priority by about 10 days over the latter name. I have here united the two names on the authority of Léveillé, since I have seen neither Léveillé's nor Gagnepain's specimens.

**Mucuna Bodinieri** Léveillé in Bull. Soc. Bot. France, LV. 408 (1908); Fl. Kouy-Tchéou, 240 (1914).

CHINA. Kweichou: dans un bois de pagode, non loin du fleuve Hoa-kiang, *E. Bodinier*, no. 2282, April 21, 1897, "grande liane . . . fleurs naissant seules sur le vieux bois" (syntype; photo. and merotype in A. A.); environs de Hoa-ko-chon, *J. Seguin*, April 6, 1898 (ex Léveillé; syntype).

This species resembles *M. pruriens* DC., but is at once distinguished by its 7-8 cm. long corolla.

**Mucuna cochinchinensis** (Lour.) A. Chevalier in Bull. Agr. Inst. Sci. Saigon, 1. 91 (1919).

*Mucuna Martini* Léveillé in Bull. Soc. Bot. France, LV. 409 (1908); Fl. Kouy-Tchéou, 240 (1914).—**Synon. nov.**

CHINA. Kweichou: environs de Ou-la-cay (Tchen-lin-tcheou), dans les buissons, *L. Martin* et *E. Bodinier*, no. 1984 "fleurs blanches en grappes" (holotype of *M. Martini*; photo. in A. A.).

This species has not yet been recorded from China, but I have little doubt that *M. Martini* is referable to it; it agrees well in leaf, fruit and flower with specimens distributed by Merrill as *M. cochinchinensis* and as *M. nivea* (Roxb.) Wight & Arn. which is a synonym of the former according to Merrill.

**Mucuna Esquirolii** Léveillé in Fedde, Rep. Spec. Nov. VII. 231 (1909); Fl. Kouy-Tchéou, 240 (1914).

CHINA. Kweichou: without locality, *J. Esquirol*, no. 885 (holotype; merotype in A. A.).

This species is chiefly characterized by the leaflets being pubescent on both sides, more densely beneath, with accumbent long white hairs, the middle leaflets elliptic-ovate and broadly cuneate at the base, by the rather small flowers with slightly curved keel and long calyx-teeth, the lower one longer than the short about 5 mm. long calyx-tube. Fruit wanting.

**Mucuna sempervirens** Hemsley in Jour. Linn. Soc. XXIII. 190 (1887).—Léveillé, Fl. Kouy-Tchéou, 240 (1914).

*Mucuna Mairei* Léveillé in Fedde, Rep. Spec. Nov. XIII. 337 (1914); Cat. Pl. Yun-Nan, 116 (1916).—**Synon. nov.**

CHINA. Yunnan: forêt de San-tao-keou, 2450 m., *E. E. Maire*, May, 1913, "fleurs violet-sombre" (holotype of *M. Mairei*; merotype in A. A.).

**Pueraria Thunbergiana** (Sieb. & Zucc.) Bentham in Jour. Linn. Soc. IX. 122 (1867).—Léveillé, Fl. Kouy-Tchéou, 241 (1914); in Mem. Acad. Ci. Art. Barcelona, ser. 3, XII. no. 22, p. 15 (Cat. Pl. Kiang-Sou) (1916).

*Pueraria Bodinieri* Léveillé & Vaniot in Bull. Soc. Bot. France, LV. 425 (1908); Fl. Kouy-Tchéou, 241 (1914).—**Synon. nov.**

*Pueraria Koten* Léveillé in Bull. Soc. Bot. France, LV. 426 (1908).—**Synon. nov.**

*Pueraria Argyi* Léveillé & Vaniot in Bull. Soc. Bot. France, LV. 426 (1908).—Léveillé in Mem. Acad. Ci. Art. Barcelona, ser. 3, XII. no. 22, p. 15 (Cat. Pl. Kiang-Sou) (1916).—*Synon. nov.*

*Pueraria coerulea* Léveillé & Vaniot in Bull. Soc. Bot. France, LV. 427 (1908).—*Synon. nov.*

CHINA. Shantung: Chefu, *E. Bodinier*, Sept. 10, 1889 (holotype of *P. Koten*; photo. in A. A.). Kiangsu: without precise locality, *Ch. d'Argy*, no. 51 [1846-66] (holotype of *P. Argyi*; merotype in A. A.). Kwangtung: Hongkong: baie de Chay-ouan, *E. Bodinier*, no. 1358, Oct. 17, 18 (holotype of *P. coerulea*; merotype in A. A.). Weichou: environs de Kouy-yang, mont du Collège, dans les rocallles, les herbes, les haies, *E. Bodinier*, no. 2489, Sept. 9, 1898 (holotype of *P. Bodinieri*, photo. in A. A.).

All four species described as new by Léveillé seem to be slight variations of the widely distributed *P. Thunbergiana*; the specimen of *P. Koten* looks rather distinct on account of its smaller three-lobed leaflets.

*Dunbaria pulchra* Bentham in Hooker, Fl. Brit. Ind. II. 218 (1879).—Léveillé, Cat. Pl. Yun-Nan, 154 (1916); China Rev. Ann. 1916, p. 21.

*Pueraria Seguini* Léveillé in Bull. Soc. Bot. France, LV. 426 (1908); Fl. Kouy-Tchéou, 241 (1914).

CHINA. Weichou: environs de Hoang-ko-chou, *J. Seguin*, no. 2446, July 10, 1898, "liane herbacée trainant sur les rochers (Siao-ko-ten), fleurs jaunes" (holotype of *P. Seguini*; photo. in A. A.).

*Pueraria Seguini* was referred to *Dunbaria pulchra* as a synonym by Léveillé himself in 1916.

(*To be continued.*)

HERBARIUM, ARNOLD ARBORETUM  
HARVARD UNIVERSITY

NOTULAE SYSTEMATICAES AD FLORAM  
SINENSEM IV.<sup>1</sup>

H. H. HU

**Carpinus Chowii, sp. nov.**

Arbor ad 5 m. alta; rami cinereo-brunnei, glabri; gemmae conico-ovoideae, 4 mm. longae, acutae, rufescentes, glabrae, perulis numerosis obtusiusculis ciliolatis. Folia ovata, circiter 3.5 cm. longa et 2 cm. lata, acuta, basi rotundata vel interdum subcuneata, grosse et subsimpliciter dentato-serrata dentibus mucronulatis, supra costa media puberula excepta glabra, subtus costa venisque pilosis et axillis barbulatis exceptis glabra, venis utrinsecus 8–10 et 2.5–3 mm. distantibus; petioli graciles, ad 8 mm. longi, puberuli. Infructescencia satis densa, ad 3 cm. longa, pedunculo 1.5 cm. longo; bracteae chartaceae, semi-ovatae, 10–12 mm. longae et 6–9 mm. latae, reticulatae, in latere convexo grosse et sparse lobato-dentatae dentibus 4–5 magnis, in latere recto interdum ad apicem serrato et basi lobo inflexo parvo in bracteis sterilibus deficiente instructae; nuculae late ovoideae, 4 mm. longae, glabrae, leviter costatae.

Tree to 5 m. high; branchlets grayish brown, glabrous; buds ovate-conical, acute, reddish, glabrous, 4 mm. long, with many imbricate obtusish ciliolate scales. Leaves ovate, acute, rounded or sometimes subcuneate at base, coarsely and subsimply mucronate-dentate-serrate, glabrous except puberulous along the midrib above, glabrous except pubescent along the midrib and lateral veins and with axillary tufts of hairs beneath, veins 8–10 pairs, 2.5–3 mm. distant, lamina to 3.5 cm. long, 2 cm. broad; petiole slender, puberulous, to 8 mm. long. Infructescence rather dense, to 3 cm. long, peduncle 1.5 cm. long; bracts chartaceous, semiovate, reticulate, 10–12 mm. long, 6–9 mm. broad, convex side coarsely and sparsely lobate-dentate with 4–5 large teeth, straight side occasionally serrate at apex, with a minute inflexed lobe at base; nutlet broadly ovoid, glabrous, slightly ribbed.

HOPEI: Fang-shan, alt. 500 m., common, *H. F. Chow*, no. 41730 (type), Oct. 5, 1931.

A very distinct species of the section *Eucarpinus* characterized chiefly by the rather small loosely veined, coarsely and nearly simply dentate-serrate leaves with mucronate teeth and coarsely and sparsely lobate-dentate fruiting bracts. *Carpinus Chowii* is

<sup>1</sup> For I–III. see Vol. XI. 48–50, 224–228; XII. 151–156.

apparently closely allied to *C. Turczaninowii* Hance var. *ovalifolia* Winkler, but the latter differs in more closely doubly serrate leaves and much more finely serrate but not lobulate bracts.

**Carpinus Chuniana, sp. nov.**

Arbor; ramuli graciles, pubescens villosa flavescente vestiti; gemmae globosae, 1 mm. diam., perulis paucis rotundatis imbricatis. Folia membranacea, firma, ovata vel elliptico- ad oblongo-ovata, 8-11 cm. longa et 4-6 cm. lata, acuta vel breviter acuminata, basi cordata, irregulariter et breviter duplicato-serrata vel sub-simpliciter serrata, supra costa puberula excepta glabra, subtus costa nervisque pilosis et axillis barbulatis exceptis glabra, utrinque glanduloso-punctata et reticulata, nervis utrinsecus 15-16 et 5-8 mm. distantibus trabeculis satis congestis conjunctis, petioli 8-10 mm. longi, villosuli. Infructescens densa, 8-11 cm. longa et ad 4 cm. lata, rhachi sericeo-villosula, pedunculo ad 3 cm. longa villosulo; bracteae dense imbricatae, late semi-ovatae, ad 2.5 cm. longae et 1.3 cm. latae, acutae, in latere convexo breviter dentato-serratae, in latere recto remote serrulatae et basi leviter inflexae, reticulatae, utrinque in costa hirtellae; nuculae leviter compressae, subgloboso-ovoideae, 4 mm. longae et latae, conspicue 8-costatae, glabrae et glandulosis resinosis aurantiacis conspersae.

Tree; young branchlets slender, yellowish villous-pubescent; buds globose, 1 mm. in diam., with few imbricate rounded scales. Leaves membranaceous, firm, ovate or ovate-elliptic to ovate-oblong, acute to shortly acuminate, cordate at base, shallowly and irregularly doubly or nearly simply serrate, glabrous except puberulous along the midrib above, glabrous except pilose along the midrib and veins and with axillary tufts of hairs beneath, glanduloso-punctate and reticulate on both surfaces, 8-11 cm. long, 4-6 cm. broad, veins 15-16 pairs, 5-8 mm. distant; petiole 8-10 mm. long, villous-tomentulose. Infructescence dense, 8-11 cm. long, to 4 cm. broad, rachis sericeous-villosulous, peduncle slender, to 3 cm. long, villosulous; bracts densely imbricate, broadly semi-ovate, acute, convex side shallowly dentate-serrate, straight side remotely serrate and slightly inflexed at base, to 2.5 cm. long, 1.3 cm. broad, reticulate, sparsely hirtellous along the midrib; nutlet slightly compressed, broadly rounded-ovate, 4 mm. long and broad, 8-ribbed, punctate with orange resinous glands, glabrous.

KWANGTUNG: Lokchang, C. L. Tso, no. 20872 (type), May 31, 1929.

A distinct species of the section *Eucarpinus*, characterized by the large reticulately veined leaves, long, dense infructescence and large bracts shallowly dentate-serrate on the convex side and

remotely dentate-serrate down to the base on the straight side. *Carpinus Chuniana* is closely allied to *C. Fargesiana* Winkl., but differs in the much larger cordate leaves and in the bracts being neither lobate-dentate on the convex side nor dentate-serrate to the base on the straight side.

**Raphiolepis kwangsiensis, sp. nov.**

Frutex; ramuli juniores glabri. Folia coriacea, lanceolata, circiter 6 cm. longa et 1.5 cm. lata, basi anguste cuneata et in petiolum marginatum circiter 1.5 cm. longum decurrentia, apice obtuse acuminata, obtuse remoteque serrata et leviter revoluta, supra lucide viridia, subtus fuscescentia, utrinque glabra et leviter reticulata rete leviter elevata, costa supra manifeste subtus leviter elevata. Panicula fructifera circiter 6 cm. longa et 4 cm. diam.; fructus globosus, pedicellatus, 7 mm. diam., niger.

Shrub; young branchlets glabrous, leaves coriaceous, lanceolate, narrowly cuneate and decurrent at base, obtusely acuminate at apex, remotely and obtusely serrate and slightly revolute along the margin, shining green and glabrous and reticulate with elevated midrib above, glabrous and finely reticulate with slightly elevated midrib beneath, about 6 cm. long, 1.8-1.6 cm. broad, petioles winged, about 1.5 cm. long. Flowers unknown. Fruiting panicles 6 cm. long, 4 cm. in diam.; fruits globose, pedicellate, black, 7 mm. in diameter.

KWANGSI: Me-kom, Seh-feng Dar-shan, S. Nanning, alt. 800 m., *R. C. Ching*, no. 8360 (type), Nov. 3, 1928.

Closely allied to *R. indica* Lindley, from which it differs in the lanceolate leaves.

**Raphiolepis lanceolata, sp. nov.**

Frutex; ramuli glabri. Folia coriacea, lineari-lanceolata, 2.5-6.5 cm. longa et 5-10 mm. lata, obtusa vel obtuse acuminata, basi cuneata et in petiolum 2-3 mm. longum marginatum decurrentia, glabra, valde remote et obtuse serrata et leviter revoluta, supra nitentia et rugosa, subtus laxe reticulata. Fructus globosus, 4 mm. diam., pedicellatus, niger.

Shrub; branchlets glabrous. Leaves coriaceous, linear-lanceolate, narrowly cuneate and decurrent at base, obtuse to obtusely acuminate at apex, shining green and glabrous and rugose with elevated midrib above, glabrous and slightly reticulate with prominent midrib beneath, very remotely and obtusely serrate and slightly revolute along the margin, 2.5-6.5 cm. long, 0.5-1 cm. broad; petioles winged, 2-3 mm. long. Fruits globose, black, pedicelled, 4 mm. in diam.

KWANGSI: Seh-feng Dar-shan, S. Nanning, alt. 775 m., *R. C. Ching*, no. 8060 (type). Oct. 21, 1928.

Closely allied to *R. gracilis* Nakai, from which it differs in its very narrow, remotely serrate, linear-lanceolate leaves and in its smaller fruits.

*TorriceLLia angulata* Oliv. var. *intermedia* (Harms), var. nov.

*TorriceLLia intermedia* Harms in Bot. Jahrb. xxix. 507 (1900).—Wangerin in Engler, Pflanzenr. iv.-229, p. 33 (1910).

SZECHUAN: Nanchuan, T'ai-ho-tung, *Bock & Rosthorn*, no. 1542, Sept. 1891 (type of *T. intermedia* Harms); Mt. Omei, side of thicket, alt., 1800-2000 m., *F. T. Wang*, no. 23297, July 10, 1931 (tree); between Pai-kuo-wan and Moso-ying, *C. Schneider*, no. 620 (arborescent shrub to 4 m.). YUNNAN: "plaine de Tché-hai," alt. 2500 m., *E. E. Maire* (Arnold Arb. distr. no. 294); without precise locality, *G. Forrest*, no. 10910. HUNAN: "ad minas Hsi-kwangshchan prope urbem Hsinhwa," alt. 300-900 m., *H. Handel-Mazzetti*, no. 11773, May 9, 1918. KWANGSI: Yeo-mar-shan, N. Hin-yen, alt. 1225 m., *R. C. Ching*, no. 7237, Aug. 31, 1928.

This variety differs from the type in the leaves being coarsely mucronate-dentate between the lobes and in the usually sparingly pubescent or puberulous veins of the under surface. Though Wilson's no. 4611 from Taning-hsien, eastern Szechuan is somewhat intermediate between the type and the variety, as it has a few teeth between some of the lobes, the specimens cited above are decidedly different from the type in their leaves being coarsely toothed all around between the lobes and merit to be distinguished as a variety.

FAN MEMORIAL INSTITUTE OF BIOLOGY  
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NEW SPECIES, VARIETIES AND COMBINATIONS FROM  
THE HERBARIUM AND THE COLLECTIONS OF THE  
ARNOLD ARBORETUM<sup>1</sup>

ALFRED REHDER

*Neillia hypomalaca*, sp. nov.

Frutex gracilis metralis; ramuli leviter flexuosi, hornotini fulvo-hirsuto-villosi, leviter angulati, annotini rubro-fusci. Folii lamina ambitu triangulari-ovata, 3–4.5 cm. longa et 2.5–3 cm. lata, basi subcordata vel rotundata, inciso-lobulata utrinque lobulis 3–4 acutis serratis infimo 5–8 mm. longo, in caudam dimidiata laminam aequantem serratam attenuata, supra densiuscula vel sparsius accumbenti-pilosa, subtus molliter et satis dense accumbenti-pilosa et ad costam venasque dense patentim pilosa, nervis utrinque 4–5; petiolus 3–4 mm. longus, dense fulvo-hirsuto-villosus; stipulae oblongae, 5–6 mm. longae, fere glabrae. Racemi 3–4 cm. longi, 8–14-flori floribus roseis; rhachis ut pedunculus circ. 1 cm. longus dense pilosa; bracteae caducae, glabrescentes, pedicellum subaequantes; pedicelli 3–4 mm. longi, villosi-pilosae et sparse glandulosi; calycis tubus cylindricus 8–9 mm. longus, extus basin versus sparse glandulis breviter stipitatis et pilis sparsissime conspersus vel fere omnino glaber, intus laxe villosulus, lobi lanceolati, 5 mm. longi, longe mucronato-acuminati; petala rotundato-ovati, sepalis paulo breviora, ciliolata; stamina 15–20; ovarium unicum vel raro duo, glabrum, 4 mm. longum, in stylum basi sparse et longe pilosum attenuatum; ovula 4–5.

CHINA. Yunnan: Litiping range, Mekong-Yangtze divide, east of Weihsi, *J. F. Rock*, no. 9171, in 1923, shrub 3 ft., flowers pink (type); brousse des collines à Tong-tchouan, alt. 2550 m., *E. E. Maire* (Arnold Arb. distr. no. 429) May [1910–14?] “arbuste delicat, buissonnant; fl. couleur chair”; halliers des montagnes à Ou-long, alt. 2250 m., *E. E. Maire* (Arnold Arb. distr. no. 529) May [1910–14?], “arbuste delicat, peu rameux, fl. couleur chair”; haies et halliers des collines, alt. 2500 m., *E. E. Maire* (Arnold Arb. distr. no. 41), April [1910–14?] “arbuste delicat, buissonnant, fl. couleur chair”; in shady thickets on the Li-ti-ping, lat. 27° 12' N, alt. 10000 ft., *G. Forrest*, no. 13883, June 1917 (shrub 3–4 ft.; flowers rose and white).

This species is apparently closely related to *N. sinensis* Oliver and to *N. villosa* W. W. Sm.; from the former it is easily distin-

<sup>1</sup> Continued from vol. xii. 78.

guished by the densely pubescent branches, rhachis and petioles, by the smaller subcordate and more deeply lobed leaves densely pubescent beneath and less so above and the shorter pedicels; from *N. villosa* it differs chiefly in the much smaller leaves, shorter petioles, narrower stipules, the presence of petals and the glabrous ovary. From *N. thibetica* Franch. which also has pubescent leaves, it differs chiefly in its spreading and pilose, not velutinous pubescence, more deeply lobed smaller leaves, shorter petioles, the calyx-tube not silky outside and in the glabrous ovary.

***Securinega suffruticosa* (Pall.) comb. nov.**

*Chenopodium ? suffruticosum* Pallas, Reise Russ. Reich. III. pt. 1, p. 424 (1776), nomen.

*Pharnaceum ? suffruticosum* Pallas, op. cit. III. pt. 2, p. 716, t. E, fig. 2 (1776).

*Xylophylla ramiflora* Aiton, Hort. Kew. I. 376 (1789).

*Osyris alba* Georgi, Beschr. Russ. Reich. III. 1341 (1800); non Linnaeus (ex Ledebour, Fl. Ross. III. 583).

*Phyllanthus ramiflorus* Persoon, Syn. Pl. II. 591 (1807).

*Geblera suffruticosa* Fischer & Meyer in Index Sem. Hort. Petrop. I. 28 (1835).—Ledebour, Fl. Ross. III. 583 (1851).

*Fliggea suffruticosa* Baillon, Étud. Gén. Euphorb. 592 (1858).

*Phyllanthus fluggeoides* Mueller Arg. in Linnaea, xxxii. 16 (1863).

*Phyllanthus japonicus* Mueller Arg. in Linnaea, xxxii. 52 (1863), in part.

*Securinega ramiflora* Mueller Arg. in De Candolle, Prodr. xv. pt. I. 449 (1866).—Rehder in Jour. Arnold Arb. VII. 191 (1926); VIII. 152 (1927).

*Securinega fluggeoides* Mueller Arg. in De Candolle, Prodr. xv. pt. I. 450 (1866).

*Securinega japonica* Miquel in Ann. Mus. Bot. Lugd.-Bat. III. 128 (Prol. Fl. Jap. 292) (1867), in part.

Some time ago Mr. H. C. Skeels drew my attention to the fact that *Securinega ramiflora* (Ait.) Muell. Arg. had an older specific epithet, namely "suffruticosa" going back to *Pharnaceum ? suffruticosum* Pall. of 1776. Fischer and Meyer based the type of their new monotypic genus *Geblera* on *Pharnaceum ? suffruticosum*, of which Pallas gives not only a fairly accurate, though incomplete description but also a figure of a flowering branch; this figure with the description, taking into consideration the region where the plant was collected, shows clearly that the plant described by Pallas is identical with *Securinega ramiflora*.

I am unable to find specific differences between *S. ramiflora* and *S. fluggeoides*, as I have already stated in this Journal (VII. 191 and VIII. 152); all the differences given are variable and do not hold in the numerous specimens before me. Also *Securinega japonica* Miquel, at least partly, belongs here, excluding the name bringing synonym, the specific epithet having been taken from *Hemicicca japonica* Baill. which is a synonym of *Phyllanthus flexuosus* (Sieb. & Zucc.) Muell. Arg.

*Vitis Wilsonae* Veitch apud Gard. Chron. ser. 3, XLVI. 236, fig. 101 (1909), nomen seminud.—Rehder in Sargent, Pl. Wilson. III. 428 (1917), pro synon. *V. reticulatae* Gagnep.

*Vitis reticulata* Pampanini in Nuov. Giorn. Bot. Ital. XVII. 429, fig. 13 (1910).—Rehder, Man. Cult. Trees Shrubs, 603 (1927).—Non *V. reticulata* (Thwaites) M. A. Lawson.

*Vitis reticulata* Gagnepain in Lecomte, Not. Syst. II. 12 (1911); in Sargent, Pl. Wilson. I. 103 (1911).—Non *V. reticulata* (Thwaites) M. A. Lawson.

This species was described at approximately the same time independently under the same name by Pampanini and by Gagnepain, but based in each case on different specimens; by Pampanini on Silvestri, no. 1438 and by Gagnepain on Farges, nos. 539 and 124 and on Wilson, Veitch. Exp. no. 1151. Both authors overlooked or disregarded the older homonym *Vitis reticulata* M. A. Lawson which they probably considered as based on the invalid name *Cissus reticulata* Thwaites, changed by Planchon to *Cissus retivenia* on account of the earlier *C. reticulata* Bl., which was cited by Miquel (in Ann. Mus. Bot. Lugd.-Bat. I. 81. 1863) only as a synonym of *Vitis geniculata* (Bl.) Miq. and did not become a valid name until Planchon published a description in 1887. There exists, however, a still earlier name, *C. reticulata* Willd. apud Roemer & Schultes, Syst. III. Mant. 248 (1827), which was referred to *Cissus canescens* Lam. by Kunth. *Vitis Wilsonae*, the earliest name given to this species, was not taken up, as it was considered a nomen nudum or seminudum having been published with an insufficient description and a figure of a leaf. It was identified with *V. reticulata* Gagnepain in 1917 and is now the only available name for this species.

***Acanthopanax stenophyllus* Harms f. *dilatatus*, f. nov.**

A typo recedit foliolis semper 3 (in specimine viso tandem) oblongo-oblanceolatis vel oblongo-ovovatis petiolulo brevi inclusu 6–11 cm. longis et 2–3.5 cm. latis.—Frutex inermis, glaber, ramulis brunneis levibus.

CHINA. Shensi: Yuan-ch'ii distr., Shui-wang-ping, in silva subalpina, alt. 1900 m., Harry Smith, no. 6563, July 21, 1924.

This plant is apparently an extremely broad-leaved form of *A. stenophyllus*, though at first glance it looks very distinct on account of its much broader leaflets, and particularly if compared with the other extreme of the species, *A. stenophyllus* f. *angustissimus* Rehd. (in Jour. Arnold Arb. IX. 99. 1928) with leaflets only 3–5 mm. wide. It seems hardly possible that these two extreme forms could belong to one species but I can find no other character to distinguish it from *A. stenophyllus*. From *A. Wilsonii* Harms, with which this form also may be compared, it differs in its much larger and thinner leaflets, the middle one distinctly stalked and in longer pedicels.

***Campsis Tagliabuana* (Vis.), comb. nov. (= *C. chinensis*  $\times$  *radicans*).**

*Tecoma Tagliabuana* Visiani in Atti Istit. Venet. Sci. ser. 3, iv. 135 (1859).—Meunissier in Rev. Hort. 1928, p. 310, tab.

*Tecoma hybrida* hort. ex Dippel Handb. Laubholzk. I. 48 (1889), pro syn. *T. grandiflorae*.—Jouin in Jardin, XIII. 104, tab. (1899); Garden LV. 315 (1899).—Rehder in Sargent, Trees & Shrubs, I. 93, t. 47 (1903).

*Campsis hybrida* Zabel in Ruempler, Gartenb.-Lex. 166 (1901).—Rehder in Bailey, Stand. Cycl. Hort. II. 652 (1914); Man. Trees Shrubs, 790 (1927).

*Tecoma intermedia* Schelle in Beissner, Schelle & Zabel, Handb. Laubholz-Ben. 435 (1903).

It seems strange that Visiani's name *Tecoma Tagliabuana* which was published with a full Latin description and the definite statement that it is a hybrid between *T. radicans* and *T. grandiflora*, has been completely overlooked by all the later authors and no mention of this name is found in botanical or horticultural literature, until Meunissier resuscitated it in an article in *Revue Horticole* in which he gave complete data and a colored plate of this hybrid. According to Visiani the hybrid was raised by the brothers Tagliabue apparently some time before 1859, but it does not seem to have been distributed under Visiani's name. The hybrid, however, has appeared in gardens under various other names. The first references I find are those given in 1872 by K. Koch (Dendrol. II. 308) as *T. Princei coccinea grandiflora* and in 1877 by Lavallé (Arb. Segrez. 176) as *T. radicans coccinea grandiflora*.

It is also probable that *T. radicans atropurpurea* mentioned in 1865 by Jaeger (Ziergehölze, 134) represents this hybrid; at least specimens I have seen under the name *T. atropurpurea* and *T. grandiflora atropurpurea* belong to it. Also the following names are referable to forms of this hybrid: *Tecoma grandiflora aurantia* and *T. grandiflora Princei* (Dippel, Handb. Laubholzk. I. 48. 1889); *T. chinensis aurantiaca* (Koehne, Dendr. 522. 1893); *Campsis radicans* f. *atropurpurea* Voss, *C. chinensis* f. *aurantiaca* Voss and f. *Princei* Voss (Siebert & Voss, Vilmorin's Blumengärt. I. 801. 1894); *T. radicans Princei*, *T. grandiflora rubra* Hort. Sahut and *T. grandiflora Madame Galen* Hort. Sahut (Nicholson & Mottet, Dict. Hort. Prat. v. 208, 209. 1898); *T. radicans grandiflora atropurpurea* and *T. Princei coccinea grandiflora* (Jouin in Jardin, XIII. 104. 1899); the same specific and varietal names may appear in horticultural literature or in catalogues under *Bignonia* or under *Campsis* instead of *Tecoma*.

***Lasianthus Labordei* (Lévl.), comb. nov.**

*Canthium Labordei* Léveillé in Fedde, Rep. Spec. Nov. XIII. 178 (1914); Fl. Kouy-Tchéou, 364 (1915).

**CHINA.** K w e i c h o u: district de Tsin-gay, mont de Kao-tchay,

penchant escarpe des montagnes, *J. Laborde & E. Bodinier*, no. 2109, March 7, 1898 (holotype of *Canthium Labordei* in *Herb. Edinb.*; photo. in *Herb. Arnold Arb.*); Si-mi-yao, Pa-na, Cheng-feng hsien, *Y. Tsiang*, no. 4423, Oct. 25, 1930 (low shrub in dense shade); foot of Van-ching-shan, Kiang-kow, alt. 450 m., *Y. Tsiang*, no. 7487, Dec. 8, 1930 (small tree in light wood); foot of Van-ching-shan, Yin-kiang, alt. 500 m., *Y. Tsiang*, no. 7591, Dec. 12, 1930 (low shrub, 0.30 m.); border of Ksi, Tan-ling, Tuh-shan, S. Kweichou, alt. 500 m., *Y. Tsiang*, nos. 6951 and 6956, Sept. 7, 1930 (shrub, 1 m., in dense shade).

This specimen described by Léveillé as a *Canthium*, a genus referred by K. Schumann as a section to *Plectrantha*, does not belong to that genus, as the usually 4-seeded fruit and the style divided at the apex into 4 linear stigmas clearly show. It apparently is referable to *Lasianthus* and seems most closely related to *L. longicauda* Hook. f., from which it differs chiefly in its much narrower leaves 5–14 cm. long and usually 8–16 mm. broad, with less prominent veins and obsolete veinlets and in the glabrous or nearly glabrous pedicels; the whole plant is generally quite glabrous, only on no. 6956 a slight pubescence is noticeable on the tips of the branchlets, the upper petioles and on the very young calyces. No. 7487 differs in its somewhat broader leaves being about 7 cm. long and 1.8 cm. broad, while no. 7591 differs in the leaves being rounded at the base and borne on very short petioles about 1 mm. long.

Of *Lasianthus longicauda* Hook. f. I have seen no Indian material, but two Yunnan specimens (Henry nos. 9035 and 10633) determined by Hutchinson and one Yunnan specimen collected by Delavay at Long-ki and determined by Pitard as *L. japonicus* Miq. which doubtless belongs to *L. longicauda* and not to *L. japonica* Miq. from which it differs in the quite glabrous more caudate leaves, the nearly glabrous branchlets, less pubescent calyx and in the corolla-lobes being glabrous inside except at the base, while in *L. japonica* according to Yatabe's figure (Iconog. Fl. Jap. 1. t. 28) the corolla-lobes are densely villous inside to their very tips.

(To be continued)

HERBARIUM, ARNOLD ARBORETUM  
HARVARD UNIVERSITY

## THE CRATAEGUS PROBLEM

ERNEST J. PALMER

IN LOOKING OVER the field of American taxonomic botany, as judged by the manuals, reports, and local plant lists that have been published since the beginning of the present century, it must be apparent to any one that the biggest unsolved problem and the one about which the greatest difference of opinion exists is that of the genus *Crataegus*, especially as regards the validity of the large number of species that were proposed, mostly during the first decade of the century.

There can be little wonder that when the twenty or twenty-five supposedly well-known species of the older manuals began to expand by scores and hundreds, until more than a thousand new species and varieties had been published, the first feeling of surprise on the part of the general students of botany and interested laymen, later assumed something like an attitude of dismay and incredulity, as they realized the hopelessness of attempting to become acquainted with or to identify living plants and collections of this genus from technical descriptions, in many of which only very slight characters were indicated to differentiate the proposed species.

In Gray's *Field, Forest and Garden Botany*, published in 1857, twelve species and two varieties of *Crataegus* were listed for the states east of the Mississippi River. This included native and cultivated Thorns. Ten species and four varieties, native and introduced, were recognized in Gray's *Manual of Botany*, that appeared in 1867. In 1860 Chapman published his *Flora of the Southern United States*, in which descriptions were given of eleven species and one variety, most of them being the species of Gray's *Manual*, with only three additions. Four species were mentioned in Coulter's *Manual of Rocky Mountain Botany*, in 1885. Three years later Focke, in Engler and Prantl, estimated that there were about 30 or 40 species of the genus growing in the North Temperate Zone. The Sixth edition of Gray's *Manual*, the last to appear in the 19th century, was published in 1889, and in this work only ten species and four varieties of *Crataegus* were recognized for the *Manual* range.

Up to the year 1899 about 175 names, including varieties and forms, a number of them merely on garden lists and without botanical descriptions, had been published for North American

*Crataegi*. A large proportion of these were segregates of supposedly polymorphic species, such as *C. crus-galli*, *C. coccinea*, *C. punctata*, *C. glandulosa*, *C. tomentosa*, and others.

About ten years later what may be called the period of expansion for the genus began. In 1899 and 1900 Beadle and Ashe published independently descriptions of several new species from the southeastern United States, followed quickly by many others, and Sargent a year or two later began describing many new forms, mostly found in the Northeastern and Central States. Altogether Mr. Ashe has published at least 177 species and 3 varieties of *Crataegus*, Mr. C. D. Beadle 143 species and 1 variety, and Professor Sargent more than 700 species, 22 varieties and 5 forms. A small number of Sargent's names were new combinations or were proposed as substitutes for various reasons for his own previously published species or for those of others.

The treatments of the genus that have appeared in the manuals and local floras since this period of expansion began have all been admittedly provisional and partial, with frequent shifting of ground in regard to the species recognized and the passing over entirely of many others. This is not surprising nor a matter for adverse criticism, but it serves to illustrate the difficulty of the problem.

Most compilers of local lists have in the meantime given up entirely any attempt to enumerate the Thorns of their regions, and have simply mentioned the fact that various unrecognizable species occur; some have referred their readers to the manuals or other general treatments, or have submitted collections to a few institutions or students of the genus who were willing, or who had the temerity, to undertake identifying them. The Arnold Arboretum has been called upon to pass upon a number of such collections, and in spite of the large number of types and the great amount of other material in the herbarium, as well as an extensive collection of living plants and ample literature available here, it has in many cases been a difficult matter to make determinations of some of the specimens, even when flowers or fruit were present, and in most cases it is quite out of the question to determine them from sterile specimens or from a single leaf or flower, as can often be done in such groups as the Willows, Oaks, Maples, Roses, and many others.

As a result of this situation a feeling seems to have arisen among many unprofessional and uncritical students of plant life, and even amongst some botanists, especially those not mainly concerned with taxonomy, that a hopeless confusion exists in this genus and that most if not all of the recently proposed species are

without standing and should be disregarded. It has also been suggested that the genus is in a state of mutation or instability or that the different forms have been so frequently hybridized with each other that no clear specific lines can be drawn as in other genera, and that almost any individual tree might be made the type of another so-called species.

Such a situation as the present is obviously unsatisfactory and unscientific, but much of the uncertainty and skepticism, understandable as it is, does not seem to be entirely warranted by the facts. For it is probably true that morphological characters peculiar to and inheritable in segregable groups of individuals that we call species are generally as constant and well marked in this genus as in many other genera of the *Rosaceae* or other families, such as *Rubus*, *Rosa*, *Prunus*, *Cotoneaster*, or *Rhododendron*. The main difference and difficulty in regard to *Crataegus* as contrasted with such other genera is that of size, the very large number of species that must be dealt with in any adequate general treatment, their wide geographical range, and the practical difficulties of studying or collecting them in the field, with the uncertainties of seasons and irregularity of fruit crop, or of bringing together under cultivation a collection at all adequate for a general revision. But in addition to this it will be generally agreed, I believe, that matters have been greatly complicated by the way in which the genus has been treated in the past in botanical literature, many of the older names having been published without recognizable descriptions or definite data as to where the plants to which they applied originated. And in regard to the much larger number of species that were distinguished later, although these were generally accompanied by fuller descriptions, much uncertainty exists because they were in many cases based upon very slight differences separating them from others, and perhaps sometimes without sufficient field study to determine the constancy of their distinctive characters, or without sufficiently careful comparison with previously described species to which the material might have been referred with a broader conception of species, under which plants with slight but evident distinctive characters might have been treated as varieties or forms of the more outstanding species.

It has long seemed to the writer that, for practical reasons, such a conservative treatment, in dealing with as large a genus as *Crataegus*, is most desirable, and studies with this in view both in the field and at the Arnold Arboretum have been in progress for several years.

In view of the great amount of work done upon the genus by

the late Professor Sargent and the accumulation of material and literature in the herbarium, plantations, and library here, it seemed evident that the Arnold Arboretum was the logical place for initiating and carrying out such a work, and indeed, that it could scarcely be done with adequate facilities anywhere else. And for this reason, after being urged to do so from a number of sources, the writer rather reluctantly undertook this difficult and somewhat formidable task.

The collection of *Crataegus* in the herbarium here is without doubt the largest and most complete in existence, and although it, naturally, does not contain specimens of all the forms of Thorns that have been described, the approximately 25,000 sheets from all parts of North America, including all of the type material of the species described by Sargent as well as isotypes of many others, have been assembled to represent as fully as possible the geographic range as well as the morphological characters and the behavior under cultivation of as many species as were obtainable.

At the beginning of Professor Sargent's intensive study of *Crataegus* he initiated the plan of planting seeds from the type tree, and from other specimens, of each of his newly described species, as well as of those previously known, and of many others from which herbarium material had been collected but which had not yet been determined. This plan has been continued, and in the thirty years that have elapsed since its beginning the plantation has grown into a collection at the present time of about 1,400 labelled trees of record, representing nearly 700 species and varieties, only a small percentage of which are of Old World origin. Other species that were grown, many of them to maturity, are no longer living, but herbarium specimens of them have in most cases been preserved. The plantation on Peters Hill at the Arboretum is now probably the largest living collection of any single genus of woody plants, or at least of trees, that has ever been brought together for the purpose of scientific study.

A critical study of the trees of this collection and a comparison of them with the herbarium specimens and record of the native parent plants from which the seed was taken has been in progress for several seasons, and it is expected to throw valuable light upon the status and relationship of many species. With this evidence it will be possible for the first time to determine in many cases whether the distinctions upon which the described species were based are constant or are merely individual variations, as well as to arrive at more definite conclusions as to the relative value of such characters as pubescence, the number of stamens and styles,

color of the anthers, shape and color of the mature fruit, &c., as specific criteria.

To examine and make notes upon this large number of trees both in the flowering and fruiting stage and to make the necessary comparisons with the herbarium material and with the published descriptions, is at best a slow process and one attended with some practical difficulties. Most of the trees have now grown to fruiting size but not all of them produce flowers or fruit each year, some seasons being quite unfavorable to the less hardy forms. Others are just coming to maturity and some flower for the first time each year. Since the flowers are very transient and it is possible to determine the color of the anthers for only a short period after they open, the season often advances so rapidly that it is difficult to keep up with them in this stage. Additional field work which is urgently needed in this genus in many parts of the range also presses at this season and for several years it has made it impossible for me to be at the Arboretum in spring.

It should also be understood that large as the collection here is, and furnishing as it does by far the best experimental data so far available, it is by no means complete or fully adequate for a study of the whole genus. Some species of the southern states have not proved hardy in this climate and for various reasons many which have been started have not survived and others have not been secured. It can easily be understood that a certain amount of error was almost unavoidable in the various steps from collecting herbarium specimens and seeds in the field, planting and germinating these, transplanting the seedlings to nursery rows, and finally to a permanent place in the collection, as well as later in keeping records and in having the plants properly labeled. A small percentage of such errors have been detected in the collection here. Some of these are so obvious as to be unmistakable and sometimes correctable, but in a few cases they may leave open to doubt questions of possible variability, which we would like to settle. In addition to this the first idea of the plantation, which seems to have been merely to illustrate the different species by typical specimens, was scarcely broad enough to furnish conclusive evidence such as might be desired to decide in some doubtful cases. It was of course impractical to attempt to grow a large number of each of the several hundred supposed species to fruiting size, but it would have been most helpful if this had been done in a few selected cases at least.

The main region of distribution for *Crataegus* in North America extends from the Atlantic seaboard to beyond the Mississippi

river, and the border of the plains. The western boundary may be roughly taken as running from northwestern Minnesota, through eastern Nebraska, Kansas, and Oklahoma, to the mouth of the Colorado river in Texas. Many of the species and several of the groups disappear much farther east, and several sub-regions may be recognized. West of this region *Crataegus* is a genus of minor importance and such scattered species as occur are mostly quite different and distinct from those of the east, and the problem is comparatively simple. Some of the western species are associated with the Sonoran floras and range southward into Mexico, and others belong to the Rocky Mountains and Pacific floras.

A considerable part of this main area has been pretty thoroughly explored, but it should be remembered that there are still large sections of the country in which very little collecting has been done and where the *Crataegus* flora is still inadequately known.

Most of the material studied by Sargent and other recent authors was brought together as a result of intensive collecting by local students in a comparatively few limited areas. A large amount of material was left undetermined in the herbarium here, and while much of this has recently been placed with described species, a number of collections remain, with either complete or partial material, that cannot be so disposed of, and reluctant as one might be to add to the number already published, it will be necessary to describe some of these that seem clearly distinct.

The sections of North America where the *Crataegus* flora is best known and from which material is fairly adequate are the St. Lawrence valley, most of New England, New York, Pennsylvania, and parts of the Southeastern and Middle-western States and the Rocky Mountain and Pacific States. Additional field work is particularly needed in parts of Ohio, Michigan, Wisconsin, Minnesota, Iowa, Arkansas, Tennessee, Oklahoma and eastern Texas, as well as in the Piedmont regions of the Gulf States. But while there is every reason to believe that some new species and varieties will turn up in these regions, it is not likely that the number that cannot be referred to forms already known will be large.

There are doubtless many questions in regard to the genetic relationships and the ideal classification of *Crataegus*, as in other plant groups, that cannot be definitely settled on purely morphological grounds. Experimental growing of seedlings on a large scale, cross-breeding, and cytological study of the chromosomes, as well as of the physiology, histology and pathological responses of the supposed species will ultimately throw much light upon some of these, and may greatly modify our present systems of classi-

fication and conception of species. Investigations along some of these lines are now in progress at the Arnold Arboretum and elsewhere, but the practical difficulty of applying such tests to hundreds of forms of such slow-growing plants as *Crataegus* is obvious. According to Mr. W. H. Judd, propagator for the Arboretum, the seeds require from two to six years to germinate. And on an average ten years more must elapse before they grow to fruiting size.

But valuable as such investigations are, they have not yet progressed far enough, at least in the case of *Crataegus*, to be used as the basis for any scheme of classification. And indeed it scarcely seems likely that they can ever be so used except in a limited way, or that any classification based mainly upon other than obvious morphological characters can be devised that will be practicable and usable by the large and increasing number of people of all degrees of scientific attainment who are for various reasons interested in the study of plants. Of course a taxonomic arrangement based upon morphological characters should, approximately follow lines of genetic relationship, but in certain cases it probably does not do so consistently, and as in keys used in the manuals to aid in locating species, an artificial arrangement is sometimes more useful and usable than one that is concerned only with natural relationship.

In considering any scheme of classification it is well to understand clearly what the writer means by the term species or other subdivisions of the group, for there is still nothing like uniformity in the use of such terms. If we begin by recognizing that there is nothing inviolable or sacrosanct about a species, but that it is merely a convenient unit to be employed in describing a group of plants or animals having a number of recognizable characters in common, and that the limits of such a unit must be based upon the best judgment of some competent observer who has studied the group, it is evident that a considerable degree of latitude may be exercised in the use of the term. The number of species in any group will therefore vary according to whether the author takes a narrow or a broad view of the species. The decision must be more or less arbitrary, and naturally there will be room for differences of opinion about any proposed classification, and in the nature of things it must be somewhat provisional and subject to revision. It might be more accurate to refer to such units as morphological species, since they may differ greatly in limits and numbers from the species concept of the geneticist or cytologist.

A system of classification in which only species are recognized, and

one in which consequently only Linnaean binomials need be employed, has its obvious advantages in simplicity, especially in small groups. But to attempt to treat such a large genus as *Crataegus* in this manner would result either in an enormous and unwieldy number of species, or specific lines would have to be drawn so broadly and with so many exceptions as to make them almost useless. A conservative treatment, such as seems desirable here, should regard as species all readily recognizable forms that can be distinguished by a group of characters or at least by more than one clear difference, with descriptions broad enough to allow for a reasonable amount of individual variation, to be determined by observation. Under varieties would be placed such subdivisions of the species as differ from the typical form of the description in a single clearly recognizable character or in one or more minor details. And in some cases it might be desirable to give names to forms in which a single distinguishing character less clear or constant is found.

Under such a treatment the number of species might be considerably reduced from the present total, but it would still be large, probably much larger than in any other genus of woody plants in the American flora, unless we refuse arbitrarily to recognize as species forms quite as well marked as many of those generally so treated in other genera. Such a course would go far towards defeating its own purpose.

Although no satisfactory general treatment of *Crataegus* has yet appeared since the publication of the large number of recently proposed species, some progress has been made towards a better understanding of the genus. New combinations have been made by Mr. Eggleston and others reducing a large number of species to varietal rank, and many others have been treated as synonyms. In many cases the view taken is probably correct and constitutes a real contribution, but in regard to others there seems to be very good ground for maintaining them as species, based upon our observations here. This is quite understandable, since it is not likely that any two students working critically on so large a group could agree in all cases. It must also be admitted that some provisional treatment short of recognizing all of the hundreds of newly described species was urgently needed for the general manuals, and that on the whole the space given in them to this genus was as large as could have been expected. Still it is not possible to limit the number of species in a genus by law or rule, desirable as this might be in some respects. And we, therefore, have felt here that it will be better to proceed slowly and to collect as much data as possible before attempting a revision.

Sufficient progress has been made in observing the living collections at the Arboretum, in additional field work and in rearranging and critically studying the material in the herbarium, to make it possible to draw a few general conclusions.

The extreme complexity of the genus, the existence of many distinct forms in all parts of North America, many of them being quite local in range, and which were unrecognized and unaccounted for in the older manuals and floras, has been amply demonstrated. The recognition of this fact and the great amount of work done in making them available for study both through published descriptions and cultivation constitutes a great contribution on the part of Sargent and his co-workers and contemporaries. It cannot be too strongly emphasized that nearly all of the large number of forms described were based upon real differences. Whether these differences were sufficient to be made the basis for specific distinctions is an open question about which there can properly be much difference of opinion. In the opinion of the writer it might have been better in many cases to have treated them as varieties or forms or merely as variations of polymorphic species.

The specimens cultivated at the Arnold Arboretum show generally that the distinctive characters of the wild specimens, which were taken as the basis for the new species hold true often to the minutest particular. There are a few exceptions to this.

Besides the plantations at the Arnold Arboretum a very large number of species were grown and records kept of them by the Park Department of Rochester, New York. The collection there is available for study, and those who have been in charge of it report similar results, and indeed some of them are much more inclined to recognize and to insist upon the distinctiveness of the species than we are.

In addition to those species that can probably be more properly treated as forms or varieties, some others were published of which the names were invalid, or which cannot be maintained for various reasons. In some cases names were preoccupied or the same name was used more than once for different species by the same or by different authors. Most of these cases have already been corrected but apparently a few still remain. Duplicate descriptions undoubtedly sometimes appeared of the same plants, either by the same or by different authors working independently. This was almost unavoidable from the mass of material that was being handled, the rapidity with which the descriptions appeared, and the small amount of tabulation that had been done, as well as because the characters of some of the sections into which it has been proposed to divide the genus were not properly understood.

There is a very wide range in the variability of the leaves, flowers, fruit and several other characters in *Crataegus*, and the species can be arranged in several natural sections or groups. There have been a number of attempts at dividing the genus into these sections, with considerable variation as to the number, arrangement and limits of the groups. The oldest arrangement is that of Loudon in 1838.<sup>1</sup> In this treatment, he arranged the species of which he gave description in 15 sections, of which one (XV. *Pyracantha*) is not now included in the genus. Four others, his sections *V. Nigrae*, *X. Azaroli*, *XI. Heterophyllae*, and *XII. Oxyacantheae*, are exclusively Old World groups. His other sections are clearly recognizable and most of the names are retained, with a few changes in the placing of species. The sections of American Thorns were *I. Coccineae*, *II. Punctatae*, *III. Macracantheae*, *IV. Crus-galli*, *VI. Douglasii*, *VII. Flavae*, *VIII. Apifoliae*, *IX. Microcarpae*, *XIII. Parvifoliae*, and *XIV. Mexicanae*. To these a number of new sections have been added by later authors.

Mr. Eggleston in his treatment of the genus in the 7th edition of Gray's Manual (1907) arranged the American species that came within the geographical range of that work into 17 sections, and in the 2nd edition of Britton & Brown, Illustrated Flora (1913) he has 15 sections, some of them slightly changed in scope from the former treatment.

Professor Sargent proposed several new sections, and in his last treatment, in the 2nd edition of the Manual of the Trees of North America (1922) he arranged the arborescent species into 20 natural groups, which did not take into account the Mexican species nor the two exclusively shrubby groups, *Parvifoliae* (*Uniflorae*) and *Triflorae*. In the course of his studies of the genus he abandoned his groups *Lobulatae* and *Flabellatae* and seems to have changed his view regarding the groups *Coccineae* and *Rotundifoliae*, as well as to have accepted Beadle's name *Silvicolae* as having priority over his *Medioximae*, and *Macracantheae* of Loudon for *Tomentosae*.

Mr. Beadle, in his generally excellent treatment of the species of the southeastern United States, as it appears in the 2nd edition of Small's Flora, has carried the division of the genus into sections to an extreme degree, basing some of them, as it seems to me, upon characters of no more than specific value, and in the case of the *Crus-galli* and *Berberifoliae* scarcely that in some cases. Thirty-three sections are recognized in this work, which covers less than a third of the area of the United States.

The sections differ considerably from each other in their dis-

<sup>1</sup> LOUDON, J. C. *Arboretum et fruticetum britannicum*, II. 813-867 (1838).

tinctiveness and in the constancy of the characters by which they can be recognized. It is generally possible to definitely place most species in the proper group with the help of keys or by one familiar with them, but in most cases there is an indistinct border line where one group merges into another, and perhaps into more than one in different directions or in different areas, and it is difficult to say whether certain species belong with one or with the other. This may indicate either hybrids between species of the different groups, which is sometimes probably the true explanation, or it may indicate merely the relationship of the groups to each other and that certain intermediate species connect them. For example, in the section *Crus-galli*, which is generally one of the best marked of the larger groups, some species approach in the character of their fruit and foliage those of the section *Punctatae*, which is usually placed next to it, and in other species, the thinner or slightly lobed leaves and smaller fruit, which may finally become mellow or succulent, or in the thinner, scaly, bark of the trees, an approach to the *Virides* is found. The *Virides* group has good distinguishing characters in most cases, but besides certain species that seem in some ways intermediate with the two previously mentioned, some of the species assigned to the *Pulcherrimae* in the southeastern states have certain resemblances to this section, and in southeastern Texas species have been found that seem intermediate between *Molles* and *Virides*. There has been much uncertainty about the *Coccinea* group. Loudon obviously intended to take *Crataegus coccinea* L. as the type of this. The illustration he gives for the typical form of that species suggests some large-leaved form of such a species as Sargent's *Crataegus pedicellata*, but the description he gives seems to have been drawn from several forms that have later been considered as distinct, probably including *C. mollis*. It also is difficult and perhaps impossible to tell what Linnaeus' species was, as that too appears to have included two or more distinct things. It is not an unnatural consequence that later authors have been much confused and very hazy in the interpretation of this species, and indeed it has since been made to include either typically or as varieties, forms of many diverse species of American thorns. The group *Coccinea*, as finally used by Sargent, includes several species of the northeastern United States and Canada, having rather large, thin leaves, mostly glabrous when mature, flowers in which the styles are usually less than five, and fruit with rather small, sessile calyx, and flesh that becomes pulpy or succulent at maturity. On the one side this group approaches the *Tenuifoliae* and on the other the *Molles*, and although,

as in other cases, it is difficult to decide definitely to which of these groups certain species belong, a description broad enough to cover such a wide diversity of forms as have been included under this group and the *Molles*, as well as those of the small *Dilatatae* group of Sargent, would lose much of its taxonomic value.

The same situation seems to obtain with most of the other groups, which it is not necessary to take up in detail here. Attention may be called, however, to the fact that there are several small groups, such as *Aestivales*, *Brachyacanthea* (*Brevispinae*), *Microcarpae* and *Cordatae*, which appear to be so clearly distinct that they probably represent species that originated quite early in the history of the genus.

It seems probable that *Crataegus* was a comparatively early offshoot from the *Pomaceae* stock, but that its principal development has taken place since the Glacial periods of the Quaternary and even in very recent times. It may have originated at rather high latitudes in Eurasia in a period of favorable climatic conditions and been dispersed from a circumpolar center southward into both hemispheres before the close of the Tertiary era. This view seems to be supported by its present wide distribution and that of associated plants, and by the fact that the genera most closely related to it amongst living plants, such as *Osteomeles*, *Cotoneaster*, *Pyracantha* and *Mespilus*, are confined to the Old World. That the groups found in the two hemispheres are all, or nearly all, quite distinct would also indicate a considerable period of isolation.

Paleontological evidence seems to be rather meager for a genus so abundant and widely distributed at present, but a number of fossil species have been described, based upon either leaves or fruit, from both the Old and New World. A comparison of these with living species will be of value and may throw light upon the present distribution and relationship of the different groups.

A few generalizations can be made as to the geographic distribution of the groups and some of the species in America, and its significance.

A large proportion of the species that have been described appear to be quite local and in not a few cases the only material known is that from the type locality or from a single tree. Such species, when they come from regions that have been pretty well explored botanically, naturally fall under suspicion as to their validity, and many of them will probably prove to be only divergent forms or hybrids. Many species, however, and some of them well marked ones, are of quite restricted range. This may be accounted for in two ways: either they are comparatively recent forms that have

not been able to spread far from the point of origin, or they may be relics of ancient and disappearing types. In the case of *Crataegus* the former seems much the more probable explanation. Several considerations lead to this conclusion, but it need only be mentioned here that in the case of relic species the range is usually interrupted and they crop out in peculiarly protected or favorable spots, often widely separated from each other. This is not the case in *Crataegus*, with a very few exceptions, so far as known.

Most species of *Crataegus* are more or less pronounced calciphiles, and they are found in the greatest diversity and abundance in limestone regions. Many of them are limited to such outcrops, and the soil factor is probably an important one in determining their distribution. There are, however, some striking exceptions to this. There is a marked zoning of the groups from north to south, and to the westward they are limited by aridity, like other mesophytic plants, as they approach the plains. But there are various other minor causes, besides soil and climate that serve to limit them and that have brought about the present distribution. This is emphasized by the fact that in spite of the limits of the groups north and south in nature, the species in the main seem quite adaptable in the matter of climate, many of those native to Florida and southern Texas having proven hardy in New England.

The genus as a whole is not adapted to spreading in forest areas, and most species are essentially plants of prairie openings, borders of woods, copses, pastures and glades, or along the open banks and bluffs of streams. In primitive times such habitats in Eastern North America, where other conditions were favorable, were not of wide extent. The great unbroken forest that extended from the Atlantic coast, across the Mississippi valley, to the edge of the plains, afforded only occasional opportunities for the growth of such small trees and shrubs, and in places where they might seek to gain a foot-hold they were probably held in check by frequent fires and by grazing animals, since the young shoots, before the spines are sufficiently developed to afford protection, are eagerly eaten by the ruminants. The seeds are heavy and are not likely to be transported far except when carried by water or in the stomachs of birds and other animals. The latter seems to be an important means for their dissemination at present, but so long as favorable localities were lacking this would avail little, and their advance was also probably impeded by the slow germination of the seeds.

Since the clearing away of the forest on such a large scale, vastly greater areas have become available and there has undoubtedly

been a great increase in their development and in the spread of species in recent years.

The distinct calciphiles and rock growing species, or those of more specialized requirements, are usually the most limited in their range, and the more widely distributed ones, such as *Crataegus crus-galli*, *C. punctata*, *C. viridis*, *C. apiifolia*, *C. spathulata*, *C. Margaretta*, and *C. tomentosa*, are such as grow in alluvial ground or that follow the courses of large drainage basins.

In general it may be thought that the more widely distributed species are the ancient ones, or that at least they are not of very recent origin. The criterion of age and origin is probably, however, only partly reliable in this genus, since other factors, as pointed out, have served to aid or retard their extension. In the writer's opinion the groups *Aestivales*, *Brachyacantheae* and *Mexicanae* are probably most closely related amongst American Thorns to the primitive types, and none of these have a particularly wide geographical range. In the case of *Aestivales*, at least, this may be due to the peculiar and limited habitat. And it is probable that all of them are retreating or disappearing groups.

A striking exception to the usual soil preference and habitat of most of the groups is afforded by the large association of forms which has been classed under *Flavae*, although Mr. Beadle divides them into twelve or fourteen sections, of which it may be desirable to maintain some. These are restricted to the southeastern United States, where they are very abundant, and they are for the most part decidedly oxylophiles, inhabiting dry, sandy, upland woods, or areas occupied also by a peculiar stunted shrubby flora, known as "scrub" in Florida, where the soil is a deep fine deposit of nearly pure sand. Typical trees of this group have quite a distinctive habit of growth. The older trunks are clothed with a thick dark bark which is deeply fissured and cross-checked into small blocks, much as in *Cornus florida*, *Diospyros virginiana* or *Viburnum rufidulum*. The stiff, curved, branches are usually terminated by slender branchlets, which are either zig-zag or pendulous, and thickly set with single or small clusters of flowers and the foliage and inflorescence is extremely glandular. Other exclusively southern groups are the *Pulcherrimae*, *Triflorae* (*Bracteatae*), *Microcarpae*, *Brachyacantheae*, and *Aestivales*.

Uncertainty concerning the characters and limits of some of the groups, and the actual difficulty of determining to which group certain species belong seems to have been the cause of some confusion in the past and may have been responsible in some cases for the duplication of descriptions of identical plants, which can

be properly placed when brought into comparison with each other.

How far the matter of hybridization enters into the problem of the complexity and proper classification of *Crataegus* is a puzzling one, and one that cannot be settled definitely without a great deal more experimental work being carried on systematically through many years.

From what is known of the rather frequent cases of hybridization amongst other Rosaceous genera, and from the fact that several supposed hybrid species of *Crataegus*, as well as a cross with the closely related genus *Mespilus*, are in cultivation, and others are found growing spontaneously that suggest such an origin, it is almost impossible not to believe that natural hybrids do sometimes occur. Anyone who has been in a large growth of *Crataegus* in early summer, where many diverse forms are growing together, and several of them blooming simultaneously, with the wind carrying pollen, and with swarms of busy insects flitting from one flower and tree to another, can easily see how this might come about.

At the same time it must be remembered that there are many ways in which the integrity of species is protected in nature, and if this were not so, the numerous distinct forms that are found in many large genera could never have been segregated or maintained. Slight physiological differences are often enough to insure immunity, and in the case of *Crataegus*, where the period during which fertilization can be effected is very short, a difference of only a day or two in the ripening of the pollen and the receptivity of the stigmas may make cross-pollination in the wild state unlikely or impossible.

But in addition to the theoretical considerations that lend support to the belief in *Crataegus* hybrids some positive morphological evidence is found both in the intermediate characters of certain forms growing with others that may be the parent species, as well as in the high percentage of pollen sterility.

Standish,<sup>1</sup> who examined the pollen of 171 species, states that thirty-five of this number had normal pollen, sixty, from 10 to 50% sterility, forty-one, from 50 to 75%, and thirty-five from 75 to 100%. This would seem to indicate a large percent of hybrids or chromosome irregularity.

Longley,<sup>2</sup> who made studies of the chromosome structure, classes as diploids thirteen of the eighty-one species recorded, fifty-seven as triploids, and eleven as tetraploids and triploids. A considerable

<sup>1</sup> STANDISH, L. M. What is happening to the Hawthorns? (Jour. Heredity vii. 266-279. 1916.)

<sup>2</sup> LONGLEY, A. E. Cytological studies in the genus *Crataegus*. (Am. Jour. Bot. xi. 249-282. 1924.)

degree of variability in the seedling offspring of triploid or tetraploid species might normally be expected. But this, as stated above, has not been the experience with the species grown here and elsewhere, where records have been kept. The fact that so large a percentage of the forms come true to the parent type scarcely seems to lend support to the theory that they are of hybrid origin, and if that is admitted to be the case upon other evidence, it would seem to indicate that these triploid forms have developed a type of apogamous reproduction, as pointed out by Sax,<sup>1</sup> and as a consequence do not develop the variations of usual hybrids. My colleague, Dr. Karl Sax, has kindly furnished me with the results of some preliminary experiments which he has conducted to test this. The anthers and stigmas were decapitated before opening in 25 to 50 flowers of a number of selected species. Of the 39 species and varieties reported on, 16, or 41%, set fruit, ranging from one or two in most cases, to five in *Crataegus erecta*, seven in *C. pruinosa*, and eleven in *C. Oxyacantha plena*. In an experiment of this character it is also possible that injury to the flowers may have reduced the chance of setting fruit in some cases. This would seem to indicate clearly that apogamous reproduction does sometimes occur, but as in the cases of the other lines of investigation upon chromosome characters and sterility, these experiments have not so far been carried out on a sufficiently extensive scale to be conclusive in regard to many species, although they point to general conclusions. As an illustration *Crataegus pruinosa* appears to be a well marked species with a wide range. Standish reports 60% pollen sterility in the specimens of this species tested. Longley found it to be a triploid, while Moffett<sup>2</sup> reports it as a diploid. It is possible that the specimens selected were not in some cases pure-bred *C. pruinosa*. And it can easily be seen that any modification in the scheme of classification, such as changing the limits of the section, transferring species from one to another, or combining several so-called species into one, might materially alter results and conclusions based upon them. To further illustrate this: Standish found a high percentage of sterility amongst species of the *Intricatae* group, and she concludes that it is closely allied to *Coccineae*, and that all of the species of *Intricatae* may have arisen as hybrids between two species of the latter group or between one such species and some other parent. However, the ranges of the two groups are quite different from those shown on the map used

<sup>1</sup> SAX, KARL. The origin and relationship of the Pomoideae. (Jour. Arnold Arb., XII, 3-22. 1931.)

<sup>2</sup> MOFFETT, A. A. A preliminary account of Chromosome behavior in Pomoideae. (Jour. Pomology, ix. 100-110. 1931.)

to support this conclusion. The two groups do overlap in the northeastern states, but the wide range southward and westward shown for *Coccineae* results from following the treatment in Gray's Manual, which includes *Molles* with that group, and if this were done consistently the range would be more than twice as extensive. Attention may be called to the fact in this connection that Longley found the three species of *Molles* examined to be diploids and all of the twelve *Coccineae* to be triploids. The range of the *Intricatae* group also extends westward through Ohio, Indiana, Kentucky, Michigan, southern Illinois, the Ozark region of Missouri and Arkansas to eastern Oklahoma, and many of the species are found outside the range of any species of *Coccineae* or in a few cases of any *Molles* species. Moreover, on morphological grounds, I can see little evidence of a close relationship between the *Intricatae* group and the *Coccineae*, as understood here. Whatever the origin of certain of the *Intricatae* species may have been, the group as a whole is one of the better, although not one of the best, marked natural sections, and it appears to be more closely related to the *Pruinosae* and *Rotundifoliae* than to *Coccineae*. There is at least ground for suspecting that conclusions as to the status of some of the other species might be modified if experiments were carried out on a larger scale or with more certainty as to the correct identity of the material used, although this might not change the general trend of the evidence.

Two points, however, seem clear: the need of a sound taxonomic basis for all lines of botanical work, and that any classification to be of practical value must be based mainly upon morphological characters.

Sax concludes, in his paper on the origin of the Pomoideae, that:

"On a genetic and cytological basis of classification all of the present genera of the Pomoideae might be classed as genetic species under one genus. In at least one case two genera should be combined under one species."

I think it safe to say that even our most conservative taxonomists and ardent "combiners" would scarcely approve of treating all of the forms of *Crataegus* of both hemispheres, including the genus *Mespilus*, as one polymorphic species.

Hybridization, therefore, seems to be a factor that must be reckoned with, but until much more experimental work has been done it is impossible to say how large a proportion of the recorded species, and in most cases which particular ones, originated in this way.

Where hybrids have arisen between two quite distinct and well

marked species or between those of two different groups, it may sometimes be detected by their intermediate characters or peculiar behavior, but this could only be done safely by careful field study and with data as to the species growing in the vicinity where the supposed hybrid originated, and as to the possibility of cross-fertilization. A hybrid between two closely allied species of the same group would be so obscure that they could scarcely be detected or identified on morphological characters, and to try to account for forms in this way, without experimental evidence, can be little more than a guess.

On the evidence available, as well as on theoretical grounds, it would seem then that the astonishing number of forms of *Crataegus* that have been detected and described are of diverse, and many of them probably of recent origin. First, there is a very large number of species and varieties that have arisen by what may be called, for want of more precise knowledge, the normal processes of evolution, and these can naturally be accounted for by the instability of triploid and polyploid species: second, there is probably a small number of hybrids between diploid, or between diploid and polyploid species, which may be expected to follow the Mendelian law of variability: and third, there is a perhaps larger group of hybrids between mostly triploid or polyploid forms, having pollen wholly or partly sterile, but which produce seed apogamously and therefore reproduce very closely all of the characters of the parent plants, thus fulfilling all of the evident requirements of normal species.

What disposition then should be made of the forms that have been described as species, of various degrees of distinctness and stability, a considerable number of which are probably of hybrid origin?

Since it has been found that the great majority of the forms grown from seed come surprisingly true to type, it seems to the writer that the practical thing to do in a general classification is to judge each recognizable form merely upon its morphological characters and where these seem sufficiently distinct to retain the specific name and treat it in all respects as a species, giving varietal rank to those less distinct. Where the evidence is available or as it becomes so, it will be desirable to indicate those species that are of hybrid origin, but the general student who is interested mainly in a workable basis for classification need not be greatly concerned with these.

The question of the relative value of the different morphological characters in diagnosing and describing species and varieties of *Crataegus* is also a debatable and perplexing one.

Professor Sargent placed strong emphasis upon the number of the stamens and the color of the anthers in distinguishing species, and Beadle, Ashe, and others also gave this as one of the key characters in many of their descriptions. So strongly was Sargent impressed with this, that in the writer's opinion, it was given undue value, and in some cases no other constant difference can be found between two described species except that of the number of stamens or the color of the anthers. Like many other characters, this seems to vary in constancy and value in the different groups and in different species within the groups. In the great majority of cases the seedlings which have been grown and studied here indicate that these characters come true with few exceptions, but that there are sometimes races or forms differing from each other only in the number of the stamens or the color of the anthers. This does not appear to me to be a satisfactory or sufficient distinction alone upon which to base species, although such races might be regarded as forms. The color of the anthers can only be determined in fresh material and for a few hours after the flowers open, and this is a practical disadvantage in using it as a key character in distinguishing species. But in some cases it seems to be the surest way of determining the identity of species where fresh flowers can be examined and mature foliage and fruit are not available.

In some species, and especially in some groups, pubescence on the foliage, young branchlets, inflorescence, or fruit is a valuable distinguishing character. But there are undoubtedly cases where this is variable and where there is both a glabrous and a pubescent form of a species. In some of the groups glands on the bracts, sepals, and leaves are abundant and conspicuous, while in some of the others they are rare or absent. This is often a valuable distinguishing character, but it is not always constant even within a species.

The size of the flowers, the number and arrangement in the corymbs, form of the ovary and calyx-lobes, the length of the pedicels and petioles, as well as the shape and serration of the leaves, are all significant characters but of varying degrees of constancy. Ecological conditions sometimes influence greatly the general appearance of a species and probably account for variability in many of these characters.

Some groups and species can be more readily distinguished by the mature leaves and fruit than in the flowering state, but the converse is also sometimes true. Perhaps mature fruit affords the best material for recognizing the groups, and often species may be

distinguished by this alone, but in all of the larger groups there are species in which the fruit is scarcely typical, or in which it is variable in size, shape or color, or sometimes in the thickness and consistency of the flesh, size of the calyx or number of the nutlets. The nest of nutlets often furnishes a definite clue to the group, but it is far too variable in some cases and there is too close a similarity in others to make it of much value in distinguishing species.

The leaves are parts of the plant that are nearly always available for study, and in a large proportion of cases, if specific lines are drawn fairly broadly, they possess recognizable differences. In fact, most of the sections or groups are distinguishable by the leaves alone. Of course it would be impossible to base a system of classification in so large a genus wholly, or even mainly, on leaf characters, but they perhaps furnish as many good characters, if both those of the fruiting branches and vigorous shoots, which often vary widely, are taken into account, as any other single feature, and they should be carefully considered in keys and descriptions.

It would have greatly simplified matters if any single organ or character, like the anther color, pubescence, glands, leaves or nutlets, were of constant value or varied consistently throughout the genus, but nature does not seem to work along lines of uniformity but upon those of the greatest diversity, and so it becomes impossible to follow any altogether uniform scheme in attempting to classify so large and variable a group as *Crataegus* into recognizable units. Any scheme adopted must be more or less eclectic and should recognize the fact that morphological characters that appear to be the most important in one section may not have equal value in another, and that each species is more or less a problem in itself.

From the foregoing I think it is apparent that the task of revising a genus of the size of *Crataegus* is a somewhat formidable one, and also one in which, with our present state of knowledge, no absolute finality can be expected. In some degree this is probably true of all taxonomic work. But it would seem that such a revision is urgently needed and that enough progress has now been made in understanding the genus to carry it out along conservative lines, that will neither seek to reduce arbitrarily species by throwing together as synonyms forms that are clearly recognizable, nor to maintain as species such as have proven to have been based on inconstant distinctions or morphological characters too slight or obscure to be worthy of specific rank. Such a treatment, while we cannot hope to devise a plan that will make a simple problem of a group of such large size and complexity and wide geographical

range, may at least do something towards simplifying it to a point where it will not be a hopeless task for the interested student to arrive at some knowledge of the principal forms or species, and if he is not particularly concerned with all the minor ones, he may do so without the expenditure of an unreasonable amount of time and study.

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## CHROMOSOME RELATIONSHIPS IN THE POMOIDEAE

KARL SAX

With plate 50

THE ROSACEAE include four tribes or subfamilies which "are all closely linked together by their floral characters" (Rehder 1927.) The basic chromosome numbers are 8 and 9 in the Spiraeoideae, 7 and 9 in the Rosoideae, 8 in the Prunoideae, but it is 17 in all the genera of the Pomoideae. Polyploidy is found in all of these subfamilies although in the Pomoideae it is limited to triploids and tetraploids with very few exceptions.

According to Darlington and Moffett (1930) the 17 pairs of chromosomes in *Pyrus* are made up from a basic number of 7 by a duplication of 4 pairs and a triplication of 3 pairs of chromosomes. The Pomoideae are considered as complex autopolyploids and their morphological characters are attributed to this reorganization of the 7 basic chromosomes. These conclusions are based on the fact that there is a tendency for the chromosomes to be associated in groups of two or three pairs at meiosis and the fact that the basic chromosome is 7 in the more important genera of the Rosoideae. These authors also describe quadrivalent and sexivalent chromosomes at meiosis in diploid species.

The writer (Sax, 1931) and Moffet (1931a, 1931b) have found that all genera of the Pomoideae have 17 chromosomes as the basic number. The different genera are closely allied as shown by their morphological characters and their breeding and grafting relationships. They have undoubtedly had a common origin and the chromosome behavior should be similar in all genera.

In most genera there is a tendency for the bivalents to be grouped in the first meiotic division, but different genera seem to vary in this respect. The chromosomes of *Crataegus* and *Cotoneaster* do show secondary association to such an extent that consistent counts are difficult, but in *Sorbus*, *Aronia* and *Amelanchier* the 17 chromosomes of diploid species are well differentiated in most cases, although there is some evidence of secondary association.

The interpretation of the quadrivalent and sexivalent associations in diploid species may well be questioned. In most cases the multivalent "pairing" shown by Darlington and Moffett is based on the apparent contact between chromosome strands at late metaphase, although one diakinesis figure (text-fig. 11) is shown with one sexivalent, four quadrivalents and six bivalents. The con-

necting strands at late metaphase are about .05 micron in diameter and the difficulty in following these strands in side views in a metaphase figure containing 17 chromosomes makes any conclusions concerning multivalent associations rather questionable. It is probably significant that "multivalent" associations from side views were found far less frequently than those derived from polar views.

Later investigations by Moffett (1931b) show that there is little, if any, real multivalent pairing in diploid Pomoideae. At diakinesis he found that "in the great majority of divisions examined 17 bivalents were observed." The occasional "quadrivalents" shown in diploid species probably do not represent true pairing of four chromosomes but is simply a grouping of two bivalents due to secondary association.

If the Pomoideae are autopolyploids with sufficient homology and chiasma formation to permit multivalent chromosome association, the chromosomes in a triploid should form either multivalents or bivalents or both, but few if any univalents. There is, however, a large proportion of univalents in triploids. Only two or three univalents were found at metaphase in *Pyrus* by Darlington and Moffett, but at anaphase as many as 9 were found. In *Pyrus minima* (= *Sorbus minima*), Moffett shows as many as 12 to 15 univalents at metaphase and anaphase. The number of lagging univalents at anaphase is undoubtedly a better index of chromosome association than counts made at earlier stages, and simply confirms the conclusion that the multivalent associations found in diploids do not represent true pairing of chromosomes.

The writer has studied several triploid forms in the Pomoideae and has found a large proportion of univalents in all cases. *Sorbaronia alpina*, a hybrid between *Sorbus Aria* and *Aronia arbutifolia* (Rehder 1926), is a triploid. Judging from the appearance of this tree it has two sets of *Sorbus* chromosomes and one set of *Aronia* chromosomes. At the first meiotic division there are about 17 bivalents or trivalents and from 6 to 15 univalents. Polar views of the first meiotic division are shown in Figures 1 and 2. The univalents are usually found around, or at one side of, the bivalents and trivalents and usually not in the same plane as shown in the side views. (Figs. 3 and 4.) It is not possible to distinguish between bivalents and trivalents in polar views and even from side views of the division figure the trivalents are not easily differentiated. There are, however, usually 17 pairs or multivalent associations of chromosomes so that the deficiency of univalents must be accounted for on the assumption that some trivalents are formed.

A few trivalent chromosomes can be observed from side views. If pairing occurs between the extra 17 chromosomes we would expect about 24 bivalent chromosomes and one univalent. At anaphase the univalents lag behind and ultimately divide. The most usual number of lagging univalents found is 11 or 12. (Figs. 5 and 6.) This observation is in accord with the numbers found at metaphase.

*Sorbopyrus auricularis bulbiformis* is also a triploid and as previously described (Sax 1931) it has about 12 univalents at the first meiotic division. (Fig. 7.)

*Malus theifera* is another triploid which shows some univalents at the first meiotic division. (Fig. 8.) The divisions in the pollen mother cells are very irregular and practically no pollen grains are found in the mature anthers. The division in the megasporangium mother cell is more regular and apparently trivalents are formed with only an occasional univalent chromosome. This species sets an abundant crop of fruit, the seeds are fertile and the seedlings are all true to type. The fact that this species is a triploid and has no functional pollen, but breeds true from seed, indicates that apomictic development occurs. The details of embryo origin and development have not yet been determined.

The evidence from triploid Pomoideae clearly indicates that there is little or no pairing among the extra 17 chromosomes and that this subfamily is not an autoploid with a basic number of 7 chromosomes. There is of course the possibility of autoploid origin so early that the originally homologous chromosomes have been so differentiated that they now show only weak affinities. But the Pomoideae are apparently of comparatively recent origin as indicated by the fertility of species and even generic hybrids, and the comparative morphology of the different genera.

It seems much more probable that the Pomoideae are allopolyploids derived from parental types with 8 or 9 chromosomes. In all other subfamilies of the Rosaceae the basic chromosome numbers for almost all genera are 7, 8, or 9. In the Spiraeoideae the basic number is 8 for *Spiraea* and *Exochorda* and 9 for *Physocarpus*, *Pentactina*, and *Sibiraea*. Hexaploid species have been found in *Spiraea*.

In the Rosoideae the basic chromosome numbers are 7 and 9. The larger genera such as *Rosa*, *Rubus* and *Potentilla* have a basic number of 7 chromosomes, but the monotypic genera *Rhodotypos*, *Kerria* and *Neviusia* each have 9 pairs of chromosomes. (Figs. 9, 10, 11.) The writer (Sax 1931) previously reported 8 pairs of chromosomes in *Rhodotypos* and *Neviusia*, but there are apparently 9 pairs. The fact that two pairs may be so closely associated that

counts are difficult suggests that some chromosome duplication may have occurred in these genera. If the Pomoideae have been derived from other subfamilies in the Rosaceae, it would seem that the Spiraeoideae and Rosoideae were involved. My colleague Mr. Rehder tells me that the Pomoideae are taxonomically more closely allied to the Spiraeoideae than to either of the other two subfamilies. Crosses between earlier types of Spiraeoideae or perhaps between primitive forms of Spiraeoideae and Rosoideae may have been the basis for the origin of the Pomoideae. Hybrids between forms close enough to cross would indicate some chromosome homologies although perhaps not close enough for chromosome pairing. Doubling of the chromosome number in the  $F_1$  hybrid would insure fertility and an allotetraploid would be produced with 17 chromosomes. The recent production of allotetraploids in different families shows that such an origin of a new type of plant is quite possible.

In such an allotetraploid there might well be sufficient affinities to produce some secondary pairing of bivalent chromosomes although real pairing to form quadrivalents would rarely or never occur. Some secondary pairing may have been present in one of the contributing diploids as suggested by the chromosome behavior in *Rhodotypos* and *Neviusia*. Lawrence (1931) has presented good evidence that secondary association of bivalents does occur in many genera, apparently due to remote affinities between chromosomes which are too well differentiated to permit multivalent chromosome pairing. As Lawrence points out such allopolyploids would have a high survival value due to hybrid vigor and a high degree of fertility. The differentiation of genera and species within the Pomoideae can be attributed primarily to mutations or minor changes in the 17 pairs of chromosomes.

#### SUMMARY

*Sorbaronia alpina*, *Sorbopyrus auricularis* and *Malus theifera* are triploids. At the first meiotic division in the pollen mother cells there are about 17 bivalents and trivalents, and from 6 to 15 univalent chromosomes. The fact that about 12 univalents are usually found in triploid forms of Pomoideae shows that this subfamily is not an autoploid with a basic number of 7 chromosomes as several writers have suggested.

The basic chromosome numbers in the other subfamilies of the Rosaceae are 7, 8, and 9. The Pomoideae may have originated from one or perhaps two of these subfamilies by hybridization between different primitive forms followed by chromosome doubling



CHROMOSOME RELATIONSHIPS IN THE POMOIDEAE.



in the  $F_1$  hybrid. Remote chromosome affinities are indicated by secondary association of bivalents in the Pomoideae. True multivalent chromosome pairing rarely, if ever, occurs in "diploid" species. The available evidence seems to indicate that the Pomoideae are allopolyploids.

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#### EXPLANATION OF PLATE 50

- Figures 1, 2, 3, 4, 5, and 7 are from permanent smear preparations of pollen mother cells. The other figures are from aceto-carmine preparations. Magnification  $\times$  3000, except Figure 8 which is  $\times$  2100.
- Figures 1-6. *Sorbaronia alpina*, first meiotic division, showing from 9 to 15 univalents at different stages and about 17 bivalents and trivalents.
- Figure 7. *Sorbopyrus auricularis bulbiformis*, first metaphase, with 14 univalents.
- Figure 8. *Malus theifera*, a triploid with univalents and bivalents or trivalents. No functional pollen is produced.
- Figure 9. *Neviusia alabamensis*, second metaphase, 9 pairs of chromosomes.
- Figure 10. *Rhodotypus scandens*, first metaphase, 9 pairs of chromosomes.
- Figure 11. *Kerria japonica*, first metaphase, 9 pairs of chromosomes.
- Figure 12. *Physocarpus monogynus*, first metaphase, 9 pairs of chromosomes.

## CHROMOSOME PAIRING IN LARIX SPECIES

HALLY JOLIVETTE SAX

With plate 51 and one text figure

THE CONIFERS show a remarkable uniformity in chromosome number. With few exceptions all the genera have twelve pairs of chromosomes (Tischler 1927). No polyploid species have been reported, and the meiotic divisions seem to be very regular. Chromosome behavior in species hybrids has never been described in the Gymnosperms.

This study was undertaken to determine whether or not there is any cytological basis for the uniformity in chromosome numbers in the Conifers, and to analyze the chromosome behavior in a species hybrid. The meiotic chromosomes have been examined in *Pinus*, *Tsuga*, *Taxus*, *Picea*, *Pseudolarix*, *Cedrus*, and *Larix*. The meiotic chromosomes are similar in all the above genera. The present analysis will be confined to two species of *Larix* and an  $F_1$  hybrid. A more detailed analysis of chiasma formation and chromatid relationships at meiosis will be published later.

*Larix eurolepis* Henry is a hybrid between *L. Kämpferi* Sarg. and *L. decidua* Mill. This hybrid is intermediate in appearance between the parental species, but possesses considerable hybrid vigor and matures its cones earlier than either parent. An account of the origin and characteristics of this hybrid has been recently published by Anderson (1931).

*Larix Kämpferi* is a native of Japan, while *L. decidua* is indigenous to northern and central Europe (Rehder 1927). This distribution of the two species would indicate that the parental types had been separated for long periods of time.

The material for the present paper was taken from specimens of these Larches growing in the Arboretum. The divisions in the pollen mother cells occurred during very cold weather. The time of division in the hybrid was between that of the two parents. During the last week in February the pollen mother cells were found dividing in *L. Kämpferi*. *L. eurolepis* produced dividing pollen mother cells throughout the first week in March. The divisions in *L. decidua* occurred the following week. Other specimens of *L. decidua*, from a different part of the Arboretum and from a different slope, were a little more advanced in this respect. Material was obtained over a period of several days in each case.

Permanent smears of the pollen mother cells were made. A number of fixatives were used. Darlington's modification of Flemming's fixative proved to be the best for *Larix*. The crystal violet-iodine stain gave the best results for work on the chromosomes.

Within a given genus chiasma frequency in the meiotic chromosomes is evidently a good index of chromosome affinities and provides an accurate method for measuring the degree of chromosome pairing in species and generic hybrids. Aase (1930) noted the greater frequency of univalents and open (single chiasma) types of bivalents in *Triticum*  $\times$  *Aegilops* hybrids than in the parents. Although Aase did not use the term "chiasma" in her description of chromosome pairing, the different types of bivalents were observed and discussed. Darlington (1931b) and Hollingshead (1932) have corroborated Aase's observations in *Triticum* hybrids, and they have discussed the problem from the standpoint of chiasma frequency.

#### THE MEIOTIC CHROMOSOMES.

The twelve bivalents from one nucleus of *Larix decidua* are shown in figure 1. These were drawn from a side view of the metaphase figure. Each chromosome was drawn separately so that details of pairing might be observed. The chromosomes of *L. eurolepis*, the hybrid, are shown in figure 2, and those of *L. Kämpferi*, in figure 3.

The nodes are undoubtedly chiasmata, and the cross formed by the exchange of partners among the four chromatids can be observed in many chromosomes. Most of the chiasmata are approximately median or subterminal in respect to the spindle fiber attachment and the distal ends of the chromosomes. In many cases the chiasmata are terminalized with difficulty, and the chromosomes are stretched into thin strands between the fiber attachments and the chiasmata. (Figure 2b and c.) Consecutive internodes are oriented in planes more or less at right angles to each other. There is a wide separation of free arms at the distal side of the chiasmata as well as between the chiasmata. In the smear preparations no spindle fibers were observed, although, with the same fixative, paraffin sections show clear spindle fibers.

Pairing of bivalent chromosomes in *Larix* and other Conifers seems to be effected only by chiasmata,—a condition which Darlington (1931a) believes to be true for all genera. The prevalence of interstitial chiasmata at diakinesis and early metaphase indicates that there is little terminalization of chiasmata during the prophase stages of meiosis.

CHIASMA FREQUENCY IN LARIX SPECIES AND  $F_1$  HYBRID

Chiasma frequency can easily be observed in *Larix* at diakinesis and metaphase of the meiotic divisions. Counts were made in pollen mother cells where all twelve bivalents could be clearly observed. The data are summarized in Table I.

TABLE I  
Chiasma frequency in *Larix* species and  $F_1$  hybrids

	Number of cells counted	Number of Chiasmata						Total number of chromosomes	Average number of chiasmata
		0	1	2	3	4	5		
<i>Larix decidua</i>	37		19 4%	279 63%	110 25%	36 8%	0	444	2.36 $\pm$ .02
<i>Larix eurolepis</i>	51	4 7%	49 8%	294 48%	198 32%	66 10.7%	1 .001%	612	2.45 $\pm$ .02
<i>Larix Kæmpferi</i>	46		88 16%	223 40%	139 25%	98 18%	4 .007%	552	2.47 $\pm$ .03

In *Larix decidua* the chiasma frequency ranges from one to four per bivalent with an average of 2.36. In *L. Kæmpferi* the range is from one to five with an average of 2.47 chiasmata per bivalent. No univalents or precocious divisions were found in these species. In the  $F_1$  hybrid (*L. eurolepis*) the chiasma frequency is from zero to five, and the average per bivalent is 2.45. The hybrid is intermediate between the two parents, although the chiasma frequency is nearer that found in *L. Kæmpferi*. The differences in mean chiasma frequency are of doubtful significance, although these differences between the parents and between *L. decidua* and the hybrid are about three times the probable error. Univalents or precocious divisions of one bivalent were found in about eight per cent of the pollen mother cells of the hybrid. In practically all cases observed, these single chromosomes were passing to opposite poles, so that a normal distribution of chromosomes would be expected.

The distribution of chiasma frequency is shown graphically in Text figure 1. The curve of chiasma frequency in the hybrid is intermediate between those of the parental species, but the differences in the curves are of doubtful significance. The shape of the curves is similar to the condition found in *Vicia* by Mæda (1930),

which Haldane (1931) attributes to interference in chiasma formation.

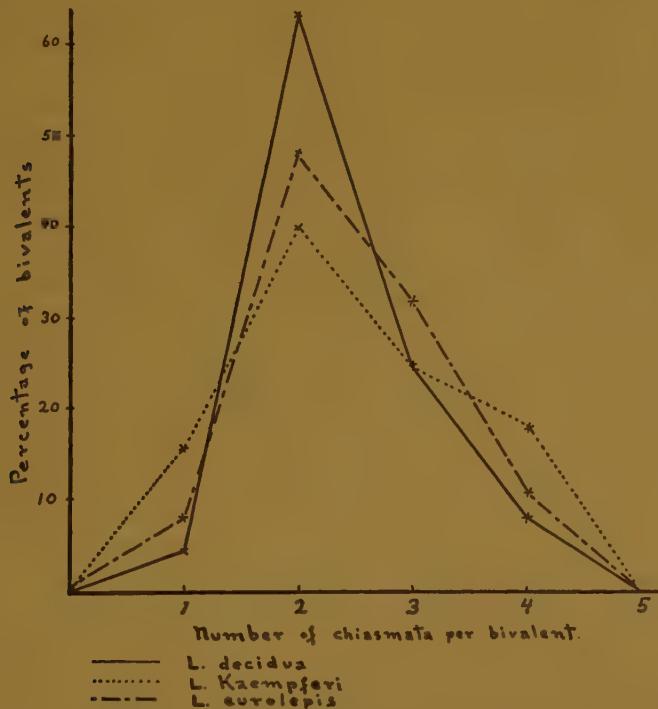


FIG. 1. CHIASMA FREQUENCY IN LARIX.

In view of the great regularity in the chromosome number, as well as the similarity in chiasma frequency between the parents and the hybrid, very little pollen sterility was expected. Counts of good and bad pollen in the parents and hybrid show greater sterility in the hybrid than in either parent. The counts and percentages of poor pollen are recorded in Table II.

TABLE II  
Pollen sterility in *Larix* species and  $F_1$  hybrid

Larix species	good pollen	poor pollen	percentage of poor pollen
			%
<i>Larix decidua</i>	614	14	2.2%
<i>Larix eurolepis</i> ( <i>L. Kaempferi</i> $\times$ <i>L. decidua</i> )	866	85	9.2%
<i>Larix Kaempferi</i>	1030	29	2.7%

## DISCUSSION

The uniformity in chromosome numbers for most genera of the Gymnosperms, and the absence of recorded cases of polyploidy, can perhaps be attributed to the type and frequency of chiasma formation at meiosis. With an average of about 2.4 interstitial chiasmata per bivalent, any autoploids produced would be expected to form closely paired tetravalents. The segregation of homologous chromosomes in such polyploids would probably be too irregular to produce a high degree of fertility, and the polyploid would have small chance of survival. Very few polyploid species occur in nature where the chromosomes pair as quadrivalents at meiosis. The only known case where a high percentage of quadrivalents is found in fertile species is in the tetraploid *Tradescantia* (Anderson and Diehl 1932). In these species the spindle fiber attachment point is approximately median, and the chiasmata are largely terminal in both diploids and tetraploids. The chromosome morphology and types of chiasmata formed might permit rather free movements of the homologous members of a quadrivalent, so that regular chromosome distribution and a high degree of fertility might be expected. With a high frequency of interstitial chiasmata, regular assortment and fertility would not be expected in autoploids. The absence of polyploid species of Conifers may also be dependent on other factors, in addition to the type and frequency of chiasma formation.

If chiasma frequency is a good index of chromosome homology, as has been shown by several writers, the chromosome constitutions of *L. decidua* and *L. Kämpferi* appear to be very similar. The average chiasma frequency is approximately the same in the parental species and the  $F_1$  hybrid. There is, however, a tendency toward weak pairing between two of the homologous chromosomes in the hybrid. In about eight per cent of the figures examined, two homologous chromosomes were not paired at early metaphase, although these two homologous chromosomes seem to pass to opposite poles. Apparently these two chromosomes are not completely homologous, but the average chiasma frequency found in the hybrid is not lower than that found in the parents.

About nine per cent of the pollen in the  $F_1$  hybrid is morphologically imperfect as compared with two or three per cent found in the parental species. The increased pollen sterility of the hybrid can not be due to irregularities in chromosome distribution at meiosis.

## SUMMARY

A detailed analysis was made of chromosome pairing in *Larix Kæmpferi*, *Larix decidua*, and a hybrid between these two species (*Larix eurolepis*). The chromosome number and the type of chiasma formation is similar in the three species and in the remainder of Conifers studied. The comparatively high number of chiasmata, together with the prevalence of the interstitial chiasmata formed here, may account largely for the great uniformity in chromosome number and general stability in the group.

The chiasma frequency was remarkably similar in all three species. The average chiasmata frequency per bivalent was 2.36 for *L. decidua*, 2.47 for *L. Kæmpferi*, and 2.45 for *L. eurolepis*.

Although there were a few cases where there was weaker pairing in the homologues in one bivalent of the hybrid, chromosome distribution appeared to be regular, and the average chiasma frequency was as high as that in the parents. The pollen sterility was somewhat greater in the hybrid than in the parents. This greater pollen sterility in the hybrid can not be attributed to irregular chromosome distribution or to difference in chiasma frequency.

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## EXPLANATION OF PLATE 51.

The figures in Plate 51 were all drawn from side views of permanent smears of pollen mother cells fixed in a modification of Flemming's solution and stained with crystal violet-iodine. Each figure shows all the chromosomes of one cell at meiotic metaphase. The drawings were made with the aid of a camera lucida. Magnification  $\times 2600$ .

Figure 1. *Larix decidua*. Chiasmata distinct, few terminal, most sub-terminal. (a) Two subterminal chiasmata. (b) Chiasma nearer fiber attachment.

Figure 2. *Larix eurolepis* (*L. Kæmpferi*  $\times$  *L. decidua*). a, a, univalents near poles. b, c, chromosomes each with chiasma near fiber attachment.

Figure 3. *Larix Kæmpferi*. Slightly earlier than above.



1



2



3

Chromosomes of *Larix*



MEIOSIS AND CHIASMA FORMATION IN  
PÆONIA SUFFRUTICOSA

KARL SAX

*With plate 52 and two text figures*

THE GENETIC evidence has shown conclusively that crossing over occurs at the four strand stage and between only two of the chromatids at any one locus (Bridges and Anderson 1925, et al.). An actual physical interchange of chromosome segments has been shown to be correlated with genetic crossing over in *Drosophila* (Stern, 1931) and in *Zea* (Creighton and McClintock, 1931). Such an interchange of chromosome segments should invariably produce an asymmetrical arrangement of the chromatids. If chiasmata are produced by previous crossovers, each chromatid will not always lie in the same quadrant at all loci. A study of chromatid organization at meiosis should throw some light on the nature of chiasma formation.

In this discussion the term *chiasma* is used to denote an apparent change of partners among the chromatids at meiosis without reference to the origin of such configurations.

If chiasmata are caused by the alternate pairing of sister and non-sister chromatids, the sister chromatids will be paired on one side of a chiasma, and homologous threads will be associated on the other side of the chiasma, as shown in diagram 1 (Fig. 1). Viewed from one angle, two of the chromatids seem to cross each other, but from another angle the other two chromatids form the cross. The apparent cross at each chiasma is formed by diagonal rather than adjacent chromatids. Each chromatid will lie in the same quadrant at all loci if no crossovers or twists in the chromatids have occurred. The pairs of chromatids on either side of a chiasma would be expected to open out at right angles to each other.

Chromosome configurations which seem to support this interpretation of chiasma formation have been described and pictured by Wenrich (1916), Robertson (1916), McClung (1927), Wilson (1925), Bělāř (1928), Carothers (1927), Taylor (1930), and others. Only in a relatively few cases is there any twisting of paired chromatids in the meiotic chromosomes pictured by these investigators, and in most cases each chromatid lies in the same quadrant at all loci. As McClung has pointed out, the clearest figures shown by Jannsens (1924) also show the chromatids in the same quadrants at all loci.

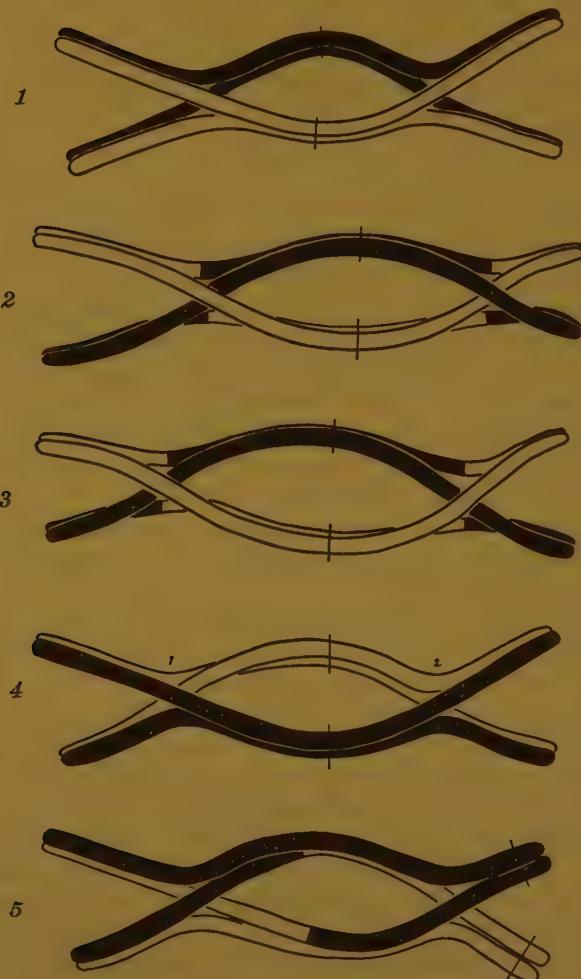


FIG. 1. DIAGRAMS OF CHIASMA FORMATION.

One pair of sister chromatids is represented by white rods and the other pair by black rods. The spindle fiber attachment points are indicated by cross lines. The term *chiasma* is used to designate the change of partners among the four chromatids of a meiotic chromosome without reference to its origin.

Diagram 1. Chiasma formation as interpreted by McClung and others. A chiasma is caused by the alternate opening out of sister and non-sister chromatids in pairs. As viewed from the end, each chromatid maintains its position in the same quadrant at all loci. Alternate internodes lie in planes at right angles to each other.

Diagrams 2 and 3. Chiasma formation according to Janssens' partial chiasmatyp hypothesis. Each chiasma is the result of a previous crossover between two of the four chromatids. Two of the chromatids do not maintain

their position in the same quadrants at all loci. The pairs of chromatids on both sides of a chiasma should tend to lie in the same plane.

Diagram 4. Chiasma formation according to McClung's interpretation, but with 2 chromatids in different quadrants at different loci, due to a half-twist in one pair of chromatids before pairing.

Diagram 5. A chiasma similar to number 1 of diagram 4, but the half twist is caused by a crossover resulting from breaks in two chromatids of a previous median chiasma. A bivalent of this type might lead to interlocking of homologous chromosomes at the first meiotic metaphase, and in this respect resembles the configuration shown in diagram 2.

Darlington (1930, figs. 8, 9, 10) and Moffett (1932, diagrams 2A, 2B), have published diagrams of chiasma formation which are in accord with McClung's interpretation. More recently Darlington and Dark (1932) have shown figures of bivalent chromosomes of *Stenobothrus* where the relations of the four chromatids can be observed at all loci in some of the chromosomes. The chromatids in the shorter chromosomes usually show a symmetrical arrangement, as would be expected if chiasmata are produced by alternate opening out of sister and homologous chromatids at diplotene. In the long bivalents pictured by Darlington and Dark it is difficult to follow the position of the chromatids at all loci, but some of the chiasmata in these chromosomes are clearly symmetrical, although some bivalents (D, fig. 6) do show asymmetrical arrangements of the chromatids. The double chiasmata analyzed were always (?) "compensating" (reciprocal) and never diagonal (equational). In *Drosophila* both types of crossovers occur with about equal frequency.

According to Jannsen's (1924) partial chiasmatyp hypothesis, a chiasma is produced by crossing over between two of the four chromatids (Fig. 1, diagrams 2 and 3). This interpretation has recently been sponsored by Belling (1931), Darlington (1931), and others. In all cases it is assumed that sister chromatids are paired at all loci, and that each chiasma represents a crossover. As shown in diagrams 2 and 3, two chromatids would not lie in the same quadrant at all loci, and the two chromatids which form the cross should be adjacent and not diagonal. At diplotene and subsequent stages the pairs of chromatids should lie in the same plane on either side of a chiasma and not at right angles to each other. As shown in another paper (Sax 1932), it is also necessary to assume, on Belling's hypothesis, that crossovers occur between sister chromatids which would produce many twists in paired sister chromatids between chiasmata. Certain types of double crossovers should result in interlocking of homologous chromosomes at metaphase, as would be the case if the spindle fiber were terminal in diagram 2 (Fig. 1). It is possible, of course, that the movement

of the chromatids would occasionally result in a symmetrical configuration where each chromatid would lie in the same quadrant at all loci, but such figures should be rare.

The most critical studies of chromatid organization and the nature of chiasma formation have been based on preparations of Orthopteran chromosomes. In this group of animals the four chromatids can often be recognized at all loci at the diplotene stage. In plant species, however, the chromatids are usually closely paired in spiral chromonemata during late prophase and early metaphase stages so that the individual chromatids can seldom be differentiated until the anaphase stage of meiosis. Newton's (1926) figures of *Tulipa* and *Fritillaria* chromosomes do show the tetrad nature of the meiotic chromosomes to some extent. According to Newton, the hypothesis "which explains the dia-kinetic figures as due to the opening out in two planes at right angles of what are originally four parallel chromatids, is adequate to explain the events of diakinesis and division in *Tulipa* and *Fritillaria*." Taylor's (1930) figures of *Gasteria* chromosomes show clearly the alternate opening out of the chromatids in pairs at right angles to each other, with each chromatid in the same quadrant at all loci. Some of his figures also show the chromatids opening out in pairs at the proximal end, but at the distal end all four chromatids are paired. Such chromosome pairing without chiasma formation can not be reconciled with Darlington's (1931) theory of chromosome pairing at meiosis. According to Darlington, chromosomes are associated only by chiasmata at the first meiotic division. In many species bivalent chromosomes are apparently associated only by chiasmata at the meiotic metaphase.

In numerous species of plants it is clear that alternate internodes of meiotic chromosomes are oriented in planes at right angles to each other, as is the case in the multiple ring chromosomes of Orthopteran species.

#### CHIASMA FORMATION IN PÆONIA

*Pæonia suffruticosa* has five pairs of large chromosomes. The haploid set of chromosomes at metaphase of the microspore division is shown in text-figure 2. Four of the chromosomes have an approximately median spindle fiber constriction, while the fifth chromosome has a subterminal fiber attachment with a trabant at the end of the short arm. The somatic chromosomes are long and slender, and even at metaphase the paired chromatids are often twisted about each other (Figure 1 of pl. 52). If the sister chromatids of homologous chromosomes are twisted at the

time of pairing at meiosis, then the chromatids will have an asymmetrical arrangement at the diplotene stage. Such meiotic chromosomes should often show half twists in paired chromatids, even if no crossovers have occurred.

The chromosomes at the meiotic prophase were so diffuse and granular in appearance that any critical study of early chiasma formation was impossible. Relatively few chiasmata seem to be present, even at the early prophase. At diakinesis the number of nodes or chiasmata can be clearly observed, but the relation of the chromatids was obscure.



FIG. 2. CHROMOSOMES IN PÆONIA MICROSPORE.

The four chromatids can usually be observed at the first meiotic metaphase, and in many cases the relations of the chromatids can be determined at all loci. The chromatids are always closely associated in pairs at the spindle fiber attachment point, but at other loci they may be well separated.

Many of the meiotic chromosomes are paired without the formation of chiasmata (Figures 4a, 4d, 7a, 10b of pl. 52). The sister chromatids appear to be paired throughout their length with no exchange of partners at any locus. At the proximal ends the chromatids have opened out in pairs, but at the distal ends all four chromatids seem to be paired. If non-sister chromatids in such figures were to open out in pairs at the distal ends, then we would expect a chiasma to be formed as shown in figure 9 (pl. 52). Only in rare cases do the distal ends of the chromatids open out to form the cross-shaped figure which is so typical in many other genera. In many cases, however, there is some separation of the paired chromatids at the distal ends of the chromosomes (Figures 2, 5,

11a of pl. 52). Homologous chromosomes which are paired at both ends usually show the sister chromatids paired only at the spindle fiber attachment and pairing of non-sister threads only at the distal ends (Figures 4b, 6b, 7c, 7d of pl. 52).

Half twists in paired chromatids are often observed (Figures 2a, 3d, 4a, 8a, 10a of pl. 52). Such half twists between the fiber attachment and the first chiasma would be expected even if no crossing over occurs.

If crossovers have occurred in the meiotic chromosomes, there should be half twists or an asymmetrical arrangement of the chromatids, but in many cases the chromatids are symmetrical and lie in the same quadrants at all loci (Figures 4c, 4d, 5, 6b, 7a, 7b, 7d of pl. 52). In the chromosomes with a single chiasma it is possible that any earlier asymmetrical relations of the chromatids might be straightened out, in some cases, by the movements of the chromatids during the early stages of division. In chromosomes with a median fiber attachment and two terminal chiasmata, such a change in the relation of the chromatids would be improbable. In some of these chromosomes there are half twists in the chromatids (Figures 4b, 7c, and 8a of pl. 52), but other bivalents show the symmetrically arranged chromatids in the same quadrants at all loci (Figures 6b and 7d of pl. 52). Half twists in the chromatids of such chromosomes may be due either to twisting before the homologues pair or to crossing over. No crossovers could have occurred in the symmetrical chromosomes, even though two chiasmata are present in each pair of chromosomes. Although these chromosomes do not have the usual types of chiasmata, the situation is essentially the same as in the multiple ring chromosomes in Orthoptera where each chromatid lies in the same quadrant at all loci (Fig. 1, diagram 1). Such figures are very difficult to interpret on the basis of the partial chiasmatyp hypothesis.

There are, however, some chromosome configurations which do support the partial chiasmatyp hypothesis. In these chromosomes the chiasma cross is formed by chromatids which were adjacent, rather than diagonal, at the four strand stage (Figures 6a and 11b of pl. 52). In these figures the two upper chromatids form the cross and lie above the other two chromatids on each side of the cross. Such a relation of the chromatids should be characteristic if chiasmata are caused by previous crossovers, as shown in diagrams 2 and 3 (Fig. 1).

This type of chiasma is difficult to account for on the hypothesis that chiasma formation precedes crossing over. If no twists occur

in pairs of sister chromatids, the chromatids which form the cross will be diagonal on each side of the chiasma (Fig. 1, diagram 1). If a half twist occurs in one pair of sister chromatids, the chromatids which form the cross will be adjacent on one side of the chiasma, but will be diagonal at the distal end, as shown in diagram 4 (Fig. 1). A rotation of the chromatids in the lower left-hand arm of this chromosome would produce a configuration like those found in figures 6a and 11b (Pl. 52), but such behavior of the chromatids might be expected only in rare cases.

The homologous chromosomes occasionally fail to pair or are separated before the first meiotic metaphase. The univalent chromosomes may pass to opposite poles (Figure 4 of pl. 52), or they may pass to the same pole (Figures 8 and 12 of pl. 52). The segregation of both homologous univalents to the same pole will result in genetic "non-disjunction" if the gametes are viable. (For further discussion, see previous paper, Sax 1932.)

Occasionally a bivalent chromosome divides with apparent difficulty, even when there is no interlocking of paired chromatids. In figure 12 (Pl. 52) a bivalent is shown held together by the attachment of two single chromatids. Such figures are common in many species.

No interlocking of homologous chromosomes was observed in *Pæonia*, and none would be expected where only one chiasma is formed between the spindle fiber and the distal end of the chromosome. Where several chiasmata are formed, some interlocking of chromosomes would be expected, and such types of bivalents are found in the Orthoptera, and in *Lathyrus* and *Lilium*. If chiasmata are formed by previous crossovers, the configuration shown in diagram 2 should result in interlocked chromosomes if the spindle fiber attachment were terminal. On the writer's hypothesis a crossover between two unbroken chiasmata should also result in interlocked homologues at metaphase (Fig. 1, diagram 5).

#### PRE- AND POST-REDUCTION.

The genetic evidence shows that in *Drosophila* the sister chromatids are always paired at the spindle fiber attachment point during the first meiotic division (Bridges and Anderson 1925, et al.). In numerous species of plants and animals the paired chromatids are associated only at the point of spindle fiber attachment at the anaphase and telophase stages of the first meiotic division, and this association is often especially clear during interphase. Since the spindle fiber attachment points can sometimes be observed soon after the chromosomes pair and before the diplotene stage, it

seems probable that sister chromatids are usually held together at the fiber constriction, as is clearly the case in *Drosophila*. Such an association of chromatids would mean that the first meiotic division is reductional at the fiber constriction and for all loci between the fiber constriction and the first crossover. Between the first crossover and the distal end of the bivalent chromosome the division is equational. If a second crossover occurs on the same side of the spindle fiber, the loci distal to the second crossover would undergo pre-reduction at the first meiotic division.

Wenrich (1916) and Carothers (1931) have described both pre- and post-reduction in heteromorphic chromosomes. According to Wenrich (figure 65) chromosome "C" in *Phrynotettix* forms only a single chiasma. One of the homologues is shorter than the other, and the two short chromatids are always paired. In about half the cases the first meiotic division is reductional, and in half the cases it is equational. On any theory of chiasma formation it would be impossible to obtain both types of reduction with only a single chiasma and a constant association of short chromatids unless the spindle fiber can be attached more or less at random to either end of the homologous chromosomes. But the spindle fiber attachment point seems to be constant for individual chromosomes of both plants and animals. In Wenrich's figure 64, showing the behavior of the unequal chromosome pair B, the segregation is equational, but in order to have an equational division, it would be necessary to assume that non-sister threads are paired at the fiber constriction or that a crossover has occurred in all cases.

Similar heteromorphic chromosomes in *Trimerotropis* have been described by Carothers (1931). The unequal homologues may undergo either pre-reduction or post-reduction, although in the few figures showing chromatid association, only a single chiasma is present, and the short chromatids are always paired. If the first meiotic division can be either pre-reductional or post-reductional, it is necessary to assume that some crossing over occurs if sister chromatids are always paired at the point of spindle fiber attachment. The behavior of unequal homologues should receive further study in connection with the implications involved concerning crossing over and the nature of chiasma formation.

#### SUMMARY

If chiasmata are formed by the alternate pairing of sister and non-sister chromatids, each chromatid may lie in the same quadrant at all loci. An asymmetrical relation of the chromatids can exist only if sister chromatids are twisted before or after synapsis or if a crossover has occurred.

If chiasmata are the result of previous crossovers, the chromatids should not lie in the same quadrants at all loci, and symmetrical arrangements of the chromatids should seldom be found.

In *Pæonia suffruticosa* the homologous chromosomes may pair at meiosis without chiasma formation. When chiasmata are found, the chromatids are often symmetrical in the bivalent chromosomes. The symmetrical relations of the chromatids in bivalents with two chiasmata are very difficult to explain on the partial chiasmatyp hypothesis. These figures are essentially the same as the types found in Orthopteran species.

Most of the asymmetrical configurations found in the *Pæonia* chromosomes could be attributed to half twists in paired sister chromatids. Some chiasmata are found, however, where the chromatids forming the cross are adjacent on both sides of the chiasma. Such a relation of the chromatids supports the partial chiasmatyp hypothesis of chiasma formation.

Occasionally one or more homologous chromosomes are not paired at the first meiotic metaphase, but pass to the poles as univalents. The segregation of two homologues to the same pole would result in genetic "non-disjunction."

In some cases homologous chromosomes are paired without chiasma formation.

Pre- and post-reduction divisions are discussed in relation to the nature of chiasma formation.

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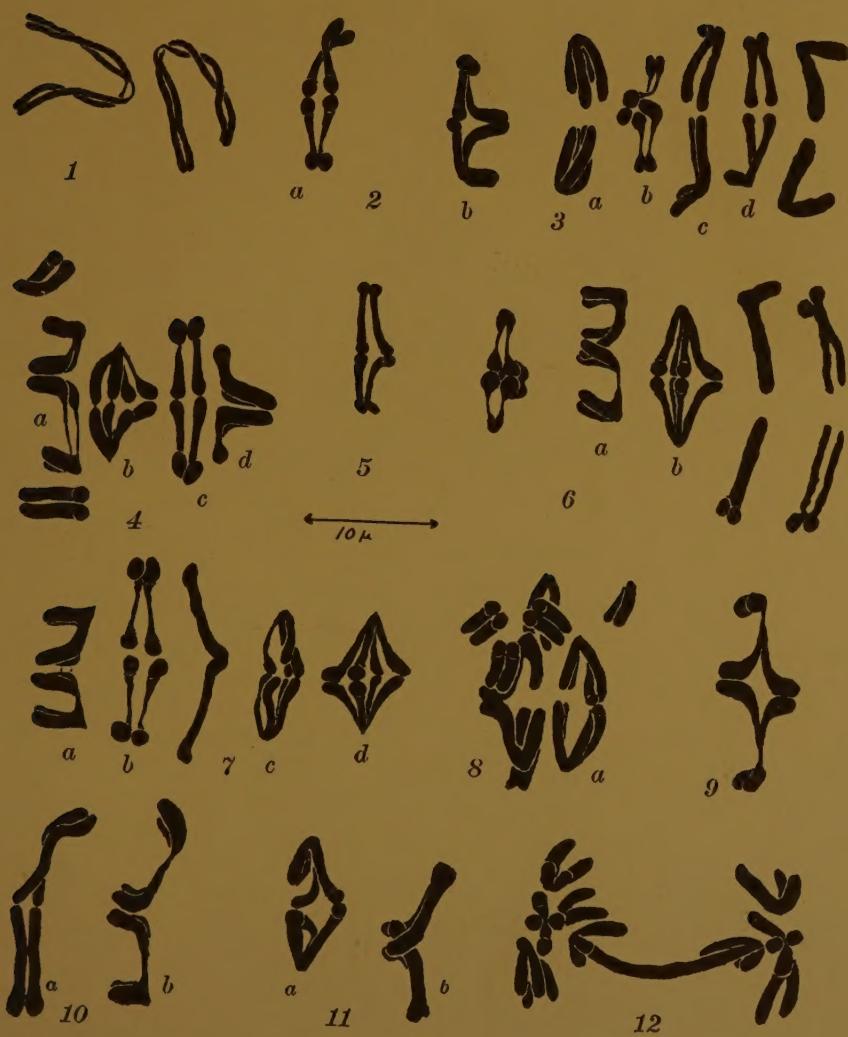
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#### EXPLANATION OF PLATE 52

Figures of meiotic chromosomes are from smear preparations of pollen mother cells of *Paeonia suffruticosa*, fixed with Navashin's solution, and stained with crystal violet iodine.

- Figure 1. Somatic chromosomes showing twisted chromatids at metaphase.
- Figure 2. Types of chiasma formation at meiotic metaphase.
- Figure 3. Early anaphase showing the five pairs of chromosomes.
- Figure 4. Metaphase showing chromosome pairing without chiasma formation in chromosomes *a* and *d*.
- Figure 5. Symmetrical arrangement of the chromatids.
- Figure 6. Chromosome 6*a* has an asymmetrical chiasma of the type expected on Jannsens' partial chiasmatypie hypothesis. The symmetrical arrangement of the chromatids in chromosome 6*b* can not be reconciled with this hypothesis.
- Figure 7. Chromosome pairing without chiasma formation (*a*) and two types of chromatid association (*c* and *d*).
- Figure 8. Twisted chromatids in chromosome *a*. Four univalents at one pole—genetic “non-disjunction.”
- Figure 9. A type of chiasma formation rarely found in *Paeonia*.
- Figure 10. Chromosome *a* shows a partial twist in sister chromatids. Evidence of stress in separating homologues of chromosome *b*, although no chiasma is present.
- Figure 11. Symmetrical (*a*) and asymmetrical (*b*) chiasmata.
- Figure 12. “Non-disjunction” of one pair of homologues and a persistent association of distal ends of “homologous” chromatids.



MEIOSIS AND CHIASMA FORMATION IN *PÆONIA SUFFRUTICOSA*.

